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Pleistocene shorelines in the southern and south-eastern Cape Province (Part 2)

by

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SYNOPSIS

Shorelines at 18, 9, 6, 3½ and 1½ m S.L. are traceable along the whole southern Cape coast as far as Cape Town. The first three form Krige's Major and Minor Emergences. Krige probably considered his Major Emergence to be the earliest pleistocene shoreline because higher beach-exposures are rare in the area in which he mainly worked, being largely masked by massive dune-rock. I have discussed the higher beaches as far as Cape Agulhas in part 1; between Cape Agulhas and False Bay very few exposures are known, but they seem to correspond in altitude with those near Riversdale. In the Cape Peninsula no certain shorelines are known even as low as 30 m, so it seems that tectonic movement and erosion have disorganized all the older deposits.

The 18-metre shoreline presents few problems. Discussion is centred on whether there were two separate transgressions to 9 m and 6 m, on evidence from morphology, artefacts, fauna and isotopic dates. The evidence from artefacts is fairly conclusive; it seems that rolled Late Acheulian and Sangoan appear in the 6-metre gravels, unrolled in the 9-metre; but many artefacts have been removed from critical sites and cannot now be traced. No fauna can be proved to be associated with the 6-metre terrace. Isotopic dates, to be used with caution, suggest that the 6-metre shoreline belongs to a Würm-interstadial; they will be discussed again for the Atlantic coast of the Cape, whence more have been obtained. The 9-metre shoreline almost certainly dates to the Eem interglacial.

In estuarine beds assignable to the 9-metre sea occurs the typical Swartkops-fauna, with a few warm-water and extinct species in addition to many still living in the southern Cape. Nearly all open beaches of the same stage lack the typical species of this fauna. Some of these species have been found in beds belonging probably to the 18-metre transgression; but fauna from this level is scanty and cannot be properly evaluated. Practically nothing has been found in the 30-metre beaches. It may be significant for an interpretation of global climatic trends that warm-water fauna occurs at the same time at both ends of Africa at about the same latitude.

The holocene transgressions, to 3½ and 1½ m, are distinguishable at many points along the whole southern Cape. A few isotopic dates indicate that the latter is after 2000 B.P.; the former, which has been recorded elsewhere in Africa, dates to about 5000 B.P. These dates confirm Fairbridge's curves of holocene rise of sea-level for steep coasts.

V. THE MAJOR AND MINOR EMERGENCES ALONG THE SOUTHERN CAPE

A. V. Krige (1927) was the first to carry out a detailed survey of raised shorelines in the Cape Province; despite the title of his paper, his work hardly extended into Natal. He identified at many places shorelines at about 18 m and 9 m above modern sea-level, and called them the Major and Minor Emergences. He was unable to prove by faunal content that his sites at each of these levels were contemporary; he took no account of contained artefacts, which at his time were little studied in South Africa; and isotopic dating belonged to the future. Nevertheless, the constancy of his levels strongly suggested that his two emergences had been on a subcontinental scale, and that sites at each level were approximately contemporary.

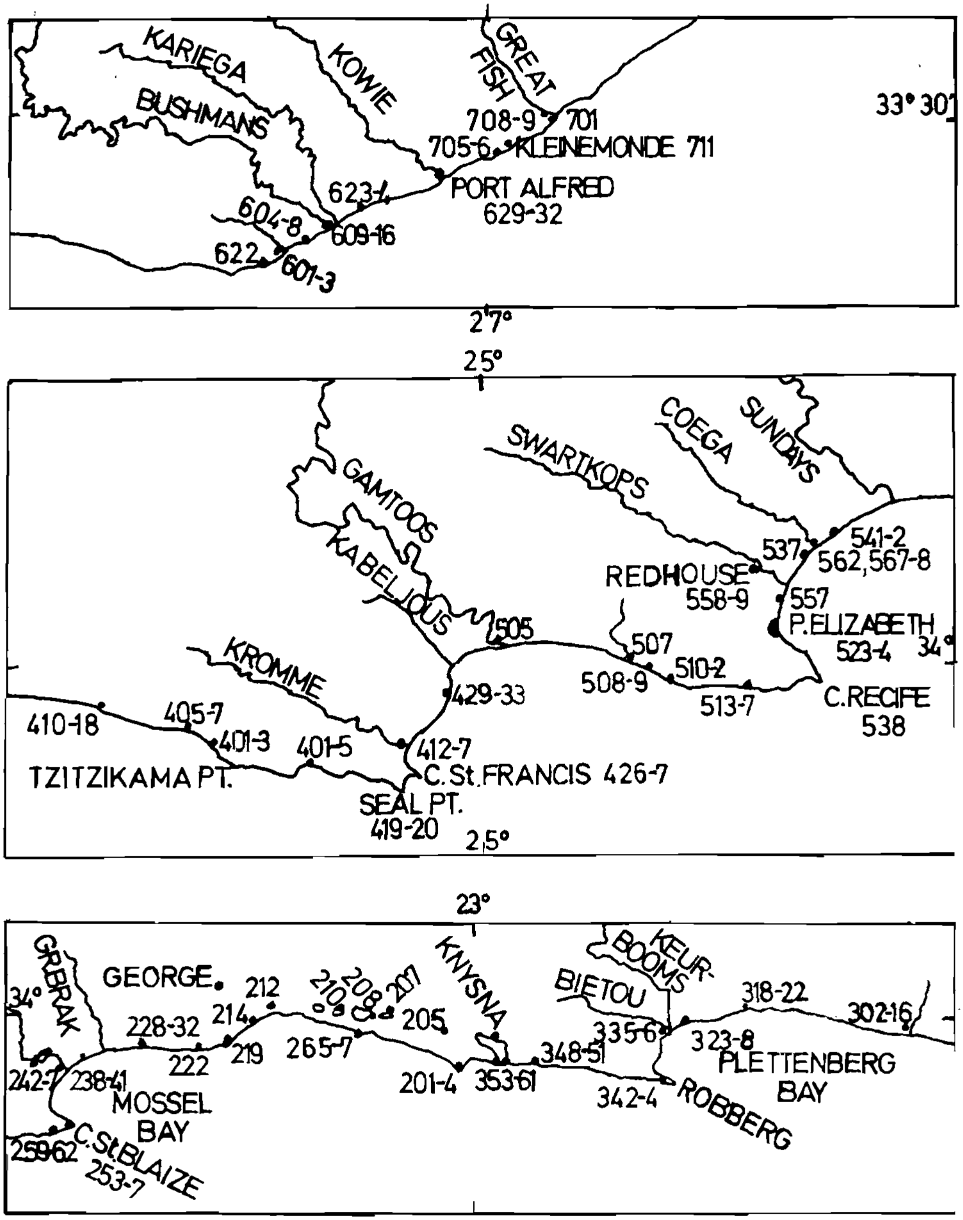

Figure 1
Map of the eastern part of the South Cape.

Krige could not determine whether the emergences were due to epeirogenetic uplift or to absolute drop in ocean-level. He was inclined to the latter view, citing the warm-water elements of the Swartkops-fauna (below p. 247). But as only a limited rise in temperature with shrinking of glaciers was conceivable, he was able to postulate that no marine level higher than 18 m is pleistocene, a view which has bedevilled subsequent shoreline-research in South Africa. This view was supported by the virtual absence of fossil shorelines above 18 m along most of the coast where he worked, in the western Cape owing to sand-cover, in the Cape Peninsula and in Tzitzikama–Outeniqua probably owing to tectonic disturbance; the pebble-spreads near Riversdale are separated from the coast by wide calcified dunes, so could well be assigned to a separate cycle; and what was known about high-level marine pebbles around Port Elizabeth and East London could not be fitted into any general picture.

In sections II, III and IV, I have discussed the shorelines above 18 m from the Great Fish River to Cape Agulhas; it remains here to summarize and amplify Krige's description of the low levels. These levels east of the Great Fish River were described in section I. Their constancy along the South Cape makes a vertical map unnecessary; localities are shown on the horizontal maps (figs 1, 17).

The Major Emergence to 18 m

Two probable exposures of the 18-metre level between R. Keiskama and Great Fish (747, 716) have been mentioned (Davies, 1971: 194). On the west bank of the Great Fish River there is a concentration of pebbles at 18 m below Fort D'acre, probably an estuarine gravel (708). On the west bank of R. Kowie, close to Port Alfred Hospital, a shale platform at about 18 m is overlain by two metres of beach-pebbles and coarse cemented shelly sand beneath dune-rock (632). The deposit appears to be marine close to the river-mouth, but is inaccessible. There are pebbles, not seen *in situ*, at about 18 m shortly above the bridge over the Riet River (706).

On R. Kariega again, west of R. Kowie, there is exposed in road-cuttings on both banks a rock-platform at 18 m overlain by quartzite pebbles which are not well flattened (619). Above the pebbles on the west bank is calcified dune with crust, and above this a later dune only slightly calcified. On the east bank the dune is reddish. Some of the pebbles on the east bank are encrusted with beach-rock and mollusc-fragments, among which Mr Kilburn has identified *Turbo cidaris*, *'Diala' dubia*, *Homalopoma carminea*, *Diodora* sp. Among the pebbles I found a few artefacts (NM 68/19):

1 rolled uniface chopper (fig. 2 2)
1 piece which may be a rolled cleaver
3 pieces rolled with one or two flakes off, perhaps artificial
1 large unrolled chopper.

There is a rock-cut terrace at 18 m, carrying large pebbles, on the west bank of Bushmans River (609) and again 2 km to west. There are probable traces of the same terrace behind Diaz' Cross (604), but its cliff has been removed by erosion. West of this point, as far as Sundays River, very wide dunes make the coast inaccessible and apparently conceal all older features.

The rivers which flow into Algoa Bay have terraces which are either estuarine or grade

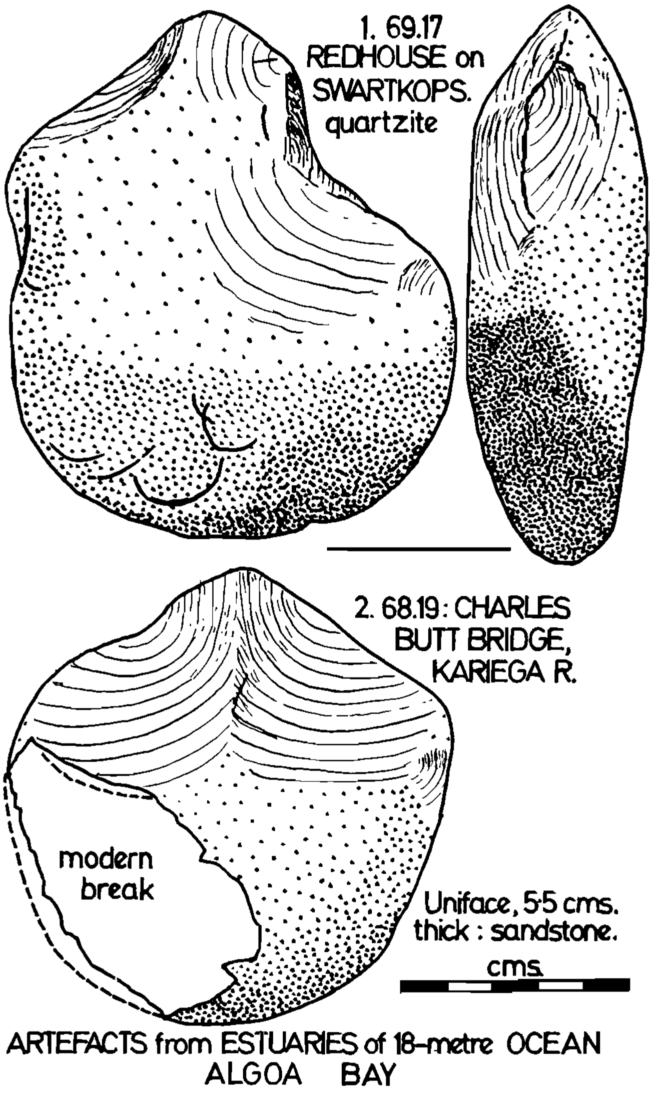

Figure 2

to a S.L. at 18 m. Ruddock (1947) identifies the Harveyton Terrace on the Sundays River (547), on the west bank from near the mouth to well upstream; near the mouth it carries beach and dune sands, upstream a boulder-bed capped by thick alluvium. Ruddock (1957) claims unrolled Late Acheulian from the gravel of this terrace.

West of the National Road bridge over R. Coega is an estuarine platform with many pebbles at 18 m (535). With the pebbles are pieces of hard conglomerate containing fragmentary shells; Mr Kilburn has recognized an *Arca* not in the area today. There was also

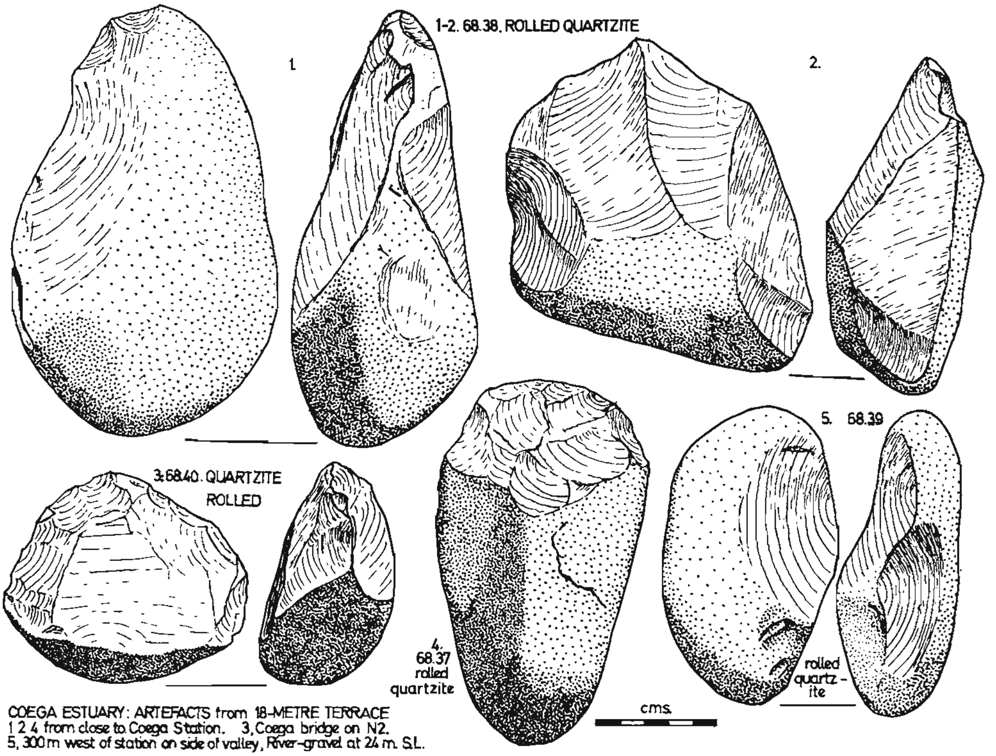
1-2. 68.38. ROLLED QUARTZITE
1.
2.
3. 68.40. QUARTZITE ROLLED
4. 68.37 rolled quartzite
5. 68.39
rolled quartz-ite
cms
COEGA ESTUARY: ARTEFACTS from 18-METRE TERRACE
1 2 4 from close to Coega Station. 3, Coega bridge on N2.
5, 300 m west of station on side of valley, River-gravel at 24 m. S.L.

Figure 3

a lightly rolled hand-axe (NM 68/40, fig. 3 3), not very typical.

Along the railway about 1½ km east-north-east of the National Road bridge and for ½ km south of the station is a gravel some 2 m thick, resting on a terrace about 17 m above the river (530). In this gravel I found several rolled Acheulian pieces (NM 68/37–8), some resharpened:

1 heavily rolled pebble-chopper
2 lightly rolled and unrolled pebble-choppers (fig. 3 4)
several large flakes, lightly rolled or unrolled
several rolled hand-axes (fig. 3 1)
1 rolled tool of chopper-cleaver type (fig. 3 2).

On the left* bank of R. Coega, about 300 m north of the main road and 500 m north of Coega station, an estuarine gravel (571) 2–2½ m thick rests on a terrace at 15–17 m M.S.L. (see also Breuil (1949), Coega VII). The terrace is about 1 km wide, rising inwards to 18 m; but is exposed only near its outer edge (fig. 4). It abuts against the eroded escarpment which rises to the 60-metre terrace at Swarte Koppen (552; see Davies, 1971: 202–3) without an intervening level. The pebbles are poorly rounded and poorly laid. Breuil considered that there are two levels in the gravel; but it appeared to me to belong to a single phase, though the lower part is heavily calcified and the upper slightly decalcified. In the gravel I found a well-rolled hand-axe with pebble-butt, perhaps Middle Acheulian; a lightly rolled flat-flaked hand-axe; and close to the surface a few unrolled flakes (finds in Port Elizabeth Museum). Breuil found Acheulian artefacts in the gravel (Jhb 92/48); from what he calls the overlying ferricrete (probably 60–90 cm of red earth) he records unrolled Late Acheulian. In the red earth I saw a few pebbles but no hand-axes: on its surface, sharp flakes of M.S.A. type.

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* I use left and right banks of a river in the correct sense in West European languages, i.e. for an observer facing downstream; South African rivers wind so much that compass-directions are meaningless.

On the left bank a short way downstream, 2 km east of the hotel, Ruddock records a gravel, with base about 15 m above the modern flood-plain, in a brick-pit (531). Artefacts are said to be Acheulian (Jhb 91/48).

Breuil's Coega I appears to be a brick-pit on the side of the valley south-south-west of the hotel (529). It seems to be the same gravel as Coega V, farther to the west upstream, and pieces from it, heavily rolled, are derived into Coega XI, 100 m to the east. Ruddock (1957) says that the terrace is at 17½–22½ m above the river; I measured it as 24 m S.L. The gravel (fig. 5) is about 3 m thick, poorly laid; on its surface are scattered pebbles which may be derived from a higher gravel, as they extend across a gully in the main gravel. This large pit has yielded many artefacts. Breuil, quoted by Ruddock, claims heavily rolled Early, lightly rolled Middle and unrolled Late Acheulian (Jhb 89/48); his chronological classification solely on degree of rolling is unacceptable. Mr W. R. Gess and I have collected from the pit-floor many unrolled Late Acheulian pieces (in Port Elizabeth Museum). In the main gravel I found at 2 m depth rolled choppers, perhaps Middle Acheulian (NM 68/39, fig. 3 5); among the scattered pebbles above it was a fairly late unrolled hand-axe.

The terrace at about 18 m continues up the Coega valley, and may be picked up again

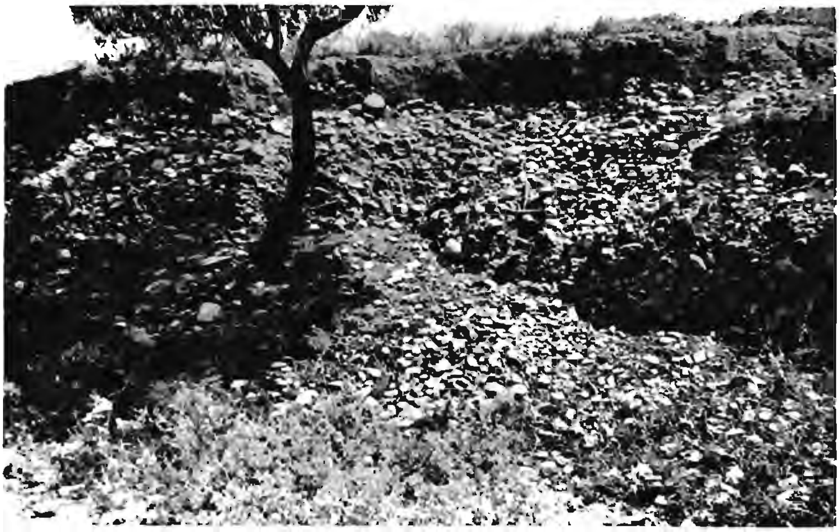


Figure 4
18-metre gravel north of Coega station, site 571.

at Hillside, on the Port Elizabeth–Addo road.

The left bank of R. Swartkops precipitously incises a gently rising slope, on which higher marine terraces cannot be distinguished. At 18 m S.L. there appears to be a platform abutting against a steeper slope which may be a degraded cliff (525). Ruddock (1968) notes the escarpment at the back of the terrace, which he records as at 14–23 m S.L., with beach-deposits beneath the terrestrial cover. There can be little doubt that this is part of the Major Emergence, much degraded by erosion; the suggestion by Engelbrecht *et al.* (1962) that it belongs to the pliocene Alexandria Beds is unacceptable.

Pebbles on a railway-cutting west of Redhouse station and over the hill to south seem derived from a gravel not lower than the top of the hill, which is at about 15 m S.L. (560). Between railway and road are, at the same altitude, small exposures of light brown estuarine silts beneath bush and humus. On them I collected a very few specimens of

Cerithium rufonodulosum
Dosinia hepatica
Loripes liratula
Nassarius kraussianus.

Some of the pebbles are broken and rolled; I found

2 probable very primitive hand-axes (NM 69/17, fig. 2 1)
1 large flake
perhaps very rough choppers.

This gravel may have been observed by Breuil at 18–30 m above river, somewhere a little upstream from where I saw it; he collected poor Acheulian pieces (Jhb 97/48).

Breuil in a MS report in the Archaeological Survey (file B 17/7 p. 3) describes at Deal Party at about 15 m a white marine gravel containing rolled Early and unrolled Late

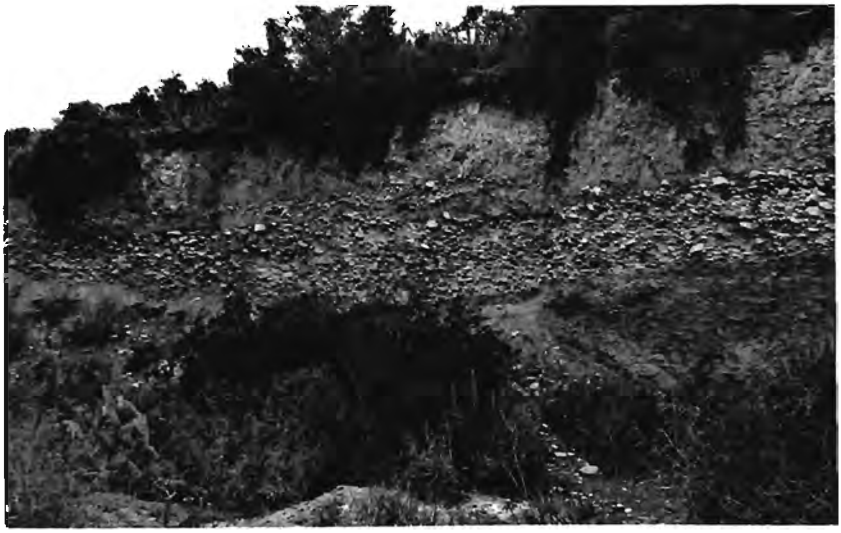


Figure 5
Gravel at about 18 m above river, Coega V s.w. of the hotel, site 529.

Acheulian, overlain by red gravel. Localization, compass-direction and altitude seem wildly inaccurate, and the site cannot be found.

The estuarine beds at Cradock (553), which presumably belong to the Major Emergence, will be discussed below with the Swartkops-fauna.

The next remains of a marine terrace at about 18 m lie beyond Port Elizabeth, on the stretch west from Cape Recife. Krige (1927: 32) records a planed surface at 15 m M.S.L. along the village of Skoenmakerskop (514), breaking off to east at Periwinkle Lane. This platform is formed by a hard crust, up to 4 m thick at the east end of the village, not more than ½ m in the centre. It is calcified beach-rock, horizontally bedded and composed of sand-grains too coarse to be aeolianite; but the only molluscs I found in it are from the surface. It rests on soft uncalcified sand containing terrestrial shells, including *Tropidophora ligata* identified by Mr Kilburn. No cliff is exposed of the 15-metre terrace, which I consider to be a low-level fragment of a beach higher than 18 m. At the west end of the village it is overlain by soft dune-sand, on which at 18 m is another crust of beach-rock (513). Of this beach also no cliff is exposed; but I consider it likely that this is the true 18-metre terrace, Krige's Major Emergence. On the surface of the dune at the base of the upper crust I found an endocast of a Mytilid. Calcified dune up to 100 m at the Kart Club overlies the 18-metre beach.

There is an estuarine terrace up to 18 m above R. Gamtoos at Mondplaas store (502), abutting against a sharp rise on the west side of the valley. This terrace has been traced upstream by Krige (1927: 32) and Haughton *et al.* (1937*a*).

Between R. Gamtoos and Kromme I did not observe any trace of an 18-metre S.L., which is probably masked by dune. On the left bank of the Kromme estuary I could not identify a rock-cut terrace between 9 m (414) and 30 m (411; Davies, 1971). On the right bank laid pebbles, probably estuarine, rest on rotten shale at 17–18 m M.S.L. at and upstream from Goedgeloof Post Office (412; see Haughton *et al.*, 1937*a*). Gravel from either this or the 9-metre terrace has been used in the streets of Seal Point village; among the pebbles I found a much rolled hand-axe (NM 68/11); as its original position is uncertain, I have not illustrated it.

There are traces of a rock-terrace at 18 m in the gap between dunes on Cape St. Francis between points 125 and 131 (426). On it, at the base of the calcified dune, I found an unrolled hand-axe, a small cleaver and numerous flakes assignable to the Mossel Bay industry (M.S.A.) (NM 68/12; fig. 6 1–3). On the dune above was an industry on pebbles (NM 68/13), unlike Mossel Bay or L.S.A. material and not clearly datable. On Cape St. Francis no cliff of the terrace is exposed; on Seal Point I found a notched cliff-base (418). There are traces of a terrace with cliff also east of Oyster Bay (402).

Along the Tzitzikama cliffs Krige (1927: 31–2) identified the 18-metre S.L. from caves at this altitude (Huisklip 402; Coldstream; see Davies, 1971). The coast is so inaccessible that there are probably many more than he lists. I cannot discuss the caves at Clasie's River (at least two with floor about 19 m, 404–5; see Singer & Wymer, 1969), until the excavations are published. Caves at Storms River Mouth (302) have been much blocked by rock-fall, so that though their present floors are at nearly 18 m, the rock-floors indicating the sea-level to which they belong are at about 8 m (Deacon, 1970). West of the mouth there are probable traces of a narrow terrace with cliff at 19 m at Swartrif (309), and the

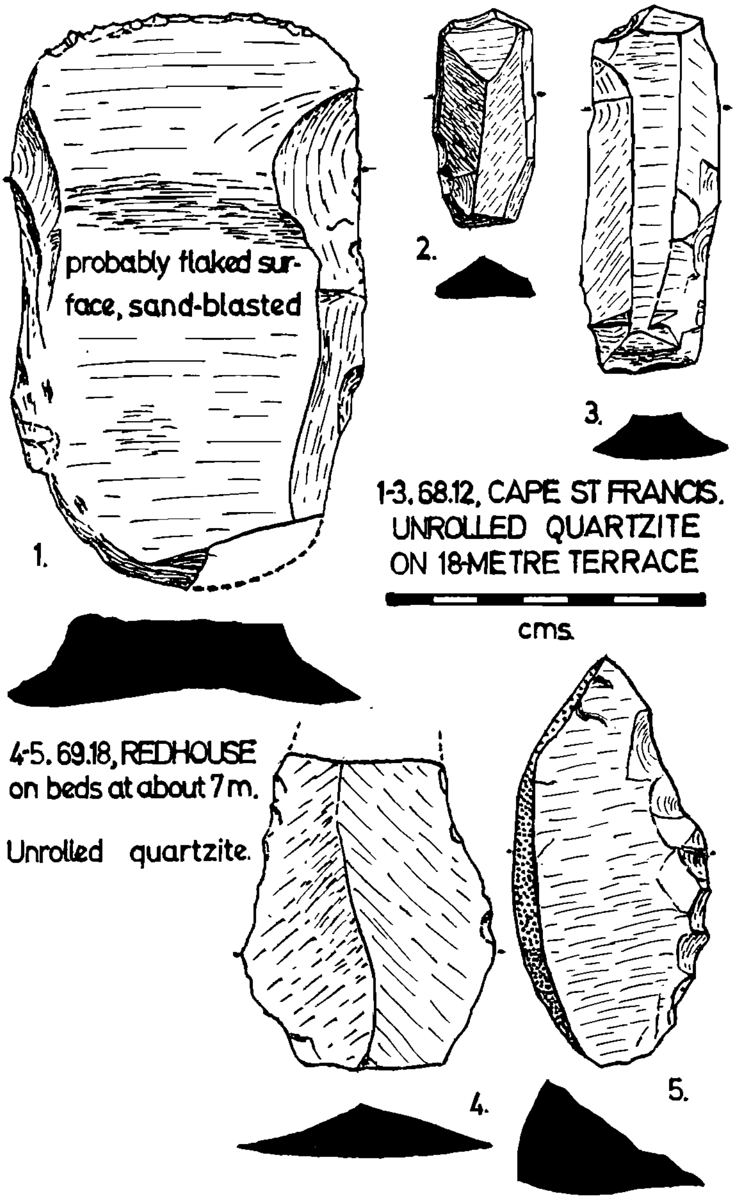


Figure 6

surface of a stack at 15 m at Gougate Point (312); but the steep dip of the rocks makes it difficult to identify true erosional surfaces.

On two little promontories west of Keurboomstrand Hotel an 18-metre beach with laid pebbles is exposed (327); on one the cliff is cut into shale, on the other into the talus of a precipitous slope. At neither exposure did I find acceptable artefacts. The hotel stands on the same platform, but its cliff is masked (324). Macfarlane (1958) and Mortelmans perhaps (1945) claim a river-terrace at 18 m close to the Keurbooms bridge. This is not today traceable; Macfarlane's observations, particularly on the west bank of the river, are inaccurate.

Between the Bietou mouth and Dieprivier a promontory with scarp at 15 m but rising westward to at least 18 m (336) is composed of chaotic and ill-rolled pebbles, probably cretaceous conglomerate reworked under water in the Pleistocene. At one corner I saw stratified lines of pebbles and gritty red sand, apparently dipping south-east. Among the pebbles were perhaps cores with rolled flake-scars, and on the surface unrolled Late Acheulian pieces. This may be the equivalent of Krige's river-terrace at 14 m above the Bietou bridge, and is probably Macfarlane's 18–21 metre terrace at Rietvlei (not on O.S.); he records finding in the gravel heavily rolled Acheulian pieces and unrolled Late Acheulian.

Macfarlane's description of a filled channel at 15 m (or 21 m) on the west bank of R. Keurbooms at the bridge is too vague to accept; no entrenched channel in the conglomerate is traceable today.

A cave at about 18 m at Rondebosch (347) and Nelson's Bay Cave at Robberg probably belong to the Major Emergence. It is uncertain if those on the southern face of Robberg (342) do, as claimed by Macfarlane (1958) and Gatehouse (1955). Their rock-floors seem considerably lower, and measurements may have been from the surface of the thick archaeological deposits.

At Knysna a probable fragment of a terrace at 18 m is preserved, on the summit of the hill carrying a few pebbles just north of the turn to Woodbourne (359). There is a cave on the north side of Coney Glen (353) at about the same height, probably that recorded by Krige as on East Head.

Between Knysna and George the only record I have of the Major Emergence is a marine or estuarine gravel on a planed terrace on both banks of R. Goukamma (205); I measured it as 21 m above river, Krige (1927: 31) and Schwarz (1899) give 18 m S.L. It is one metre thick, and composed of fair-sized well-laid pebbles of T.M.S.; the terrace is cut in sharply dipping shales. Above the gravel is partly ferruginized dune-sand. Among the pebbles I found a rough hand-axe unrolled.

A cutting just west of Klein-Brak road-bridge sections a gravel-filled channel incised into cretaceous beds (240; fig. 7). The base of the channel is at about 13 m M.S.L.; its banks are preserved up to 16,5 m. It almost certainly belonged to an estuary of the 18-metre ocean. Acheulian material was found on an 18-metre marine terrace at Riverside, Klein-Brak (Jhb 3/48); this place must belong to the same phase, but I do not know the exact site.

At Mossel Bay a cave is now exposed at the point, below the main cave at 30 m (255; Davies, 1971: 212). The filling of the lower cave is at 21 m, so its floor may be about 18 m (256).

In a road-cutting at Frog Rock just above Mossel Bay caravan-park (253) is exposed a fragment of beach, well-rounded and battered pebbles laid and set in shelly sand. The rock-platform is not visible. The beach-deposit can be traced behind the cutting up to 17,4 m S.L. At the sides of the exposure finer beach-material has been removed, and the pebbles survive irregularly in cemented dune-sand without shells. The beach is directly overlain by dune with terrestrial shells. No cliff is exposed; but on the steep slope it

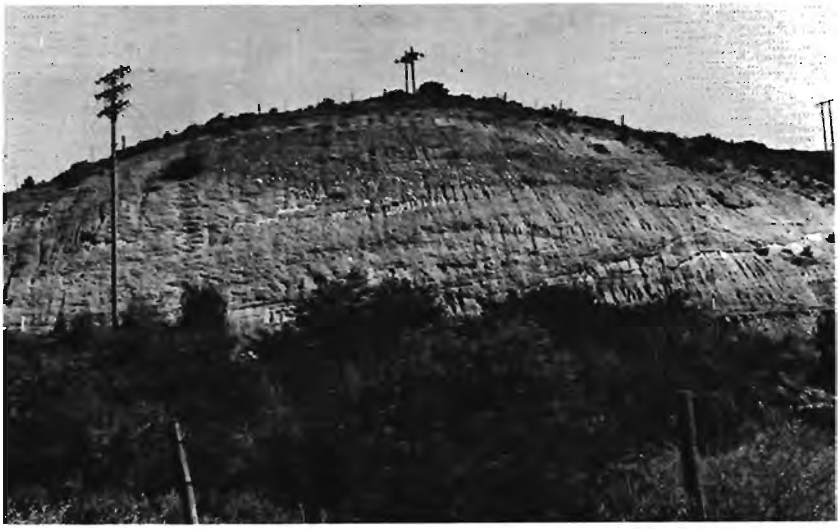


Figure 7
Klein-Brak estuary, 16-metre channel cut into cretaceous beds, site 240.

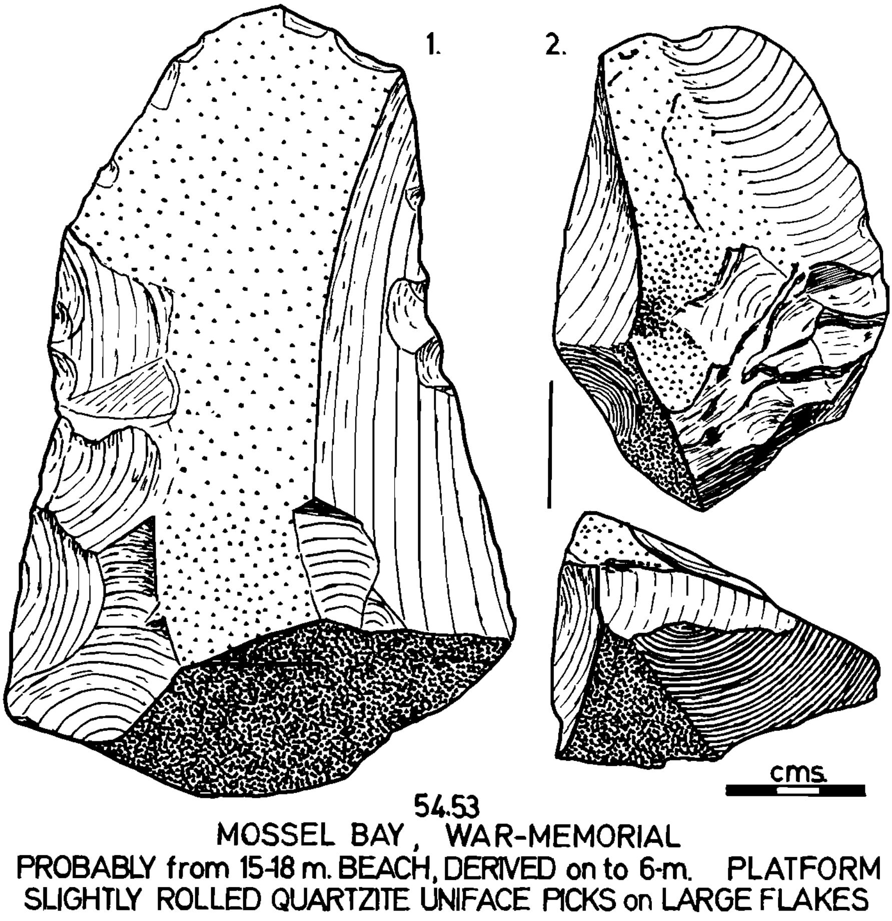
could have been masked by talus, and it is probably not far behind or above the 17,4-metre surface. Shells from the beach were identified by Mr Kilburn. They are all modern species except for one surprising specimen of *Isognomon? gaudichaudi*. This was found on Algoa Bay in beaches not lower than 60 m (Davies, 1971: 203–6); but the specimen looks rather fresh to have been derived from a higher beach, which would with difficulty have been laid down on the steep slope of the promontory. Goodwin & Malan (1935) record *Calliostoma mosselense* (*Cantharidus fultoni fultoni*) of the Swartkops-fauna from the War Memorial beach (254), which may well be a continuation of Frog Rock. Otherwise from Frog Rock:

Afrocominella elongata
Burnupena ? cincta
,, *lagenaria*
Littorina ? knysnaensis
Oxystele tigrina
,, *variegata*
Perna perna
Siphonaria deflexa
Thais capensis
,, *squamosa*
Turritella carinifera
Barbatia ? obliquata
Calyptraea helicoidea
Helcion pectunculus
Natica genuana
Patella barbara
,, *cochlear*
,, *granularis*
,, *longicosta*
,, *? tabularis*
Tricolia capensis

Material derived from this beach used to be visible at the War Memorial (254). There are conflicting accounts of the altitude of the exposure. Dreyer (1934) gives 12 m; Goodwin & Malan (1935), followed by Breuil (1945), say that its surface was at 13,5 m, its thickness 2,7 m, so its floor would be about 10,8 m; Goodwin (1933) gives the maximum altitude at the back as 8,7 m. It is unlikely that they excavated to find the rock-bench; the cliff seems not to have been exposed, and the photos published show a tumble of rolled and subangular pebbles not *in situ*. When I saw the site in 1953, no rock-bench or cliff was exposed. I measured the section, and found the exposed base (above the rock-terrace) to be at about 10,5 m S.L.; I was uncertain whether the detritus was mixed with material on a lower terrace. My section was as follows:

(*c*) Exposure of large angular blocks, probably weathered out from beach b) and covered by a little black earth, in which were unrolled M.S.A. cores flakes and blades, one blade with double notch, one crude pick and one disc (NM 55/53).

(*b*) 1,8 m of sand, apparently water-laid and containing many small marine pebbles and a few large sub-angular blocks; base at about 12 m M.S.L. The sand was well calcified and contained bands of comminuted shell. In it were a few lightly rolled artefacts, two rough picks, a chopper and a small flake (NM 54/53; fig. 8). Typologically these pieces are hardly what one would expect in an 18-metre beach.


1.
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MOSSEL BAY, WAR-MEMORIAL
PROBABLY from 15-18 m. BEACH, DERIVED on to 6-m. PLATFORM
SLIGHTLY ROLLED QUARTZITE UNIFACE PICKS on LARGE FLAKES

Figure 8

(*a*) Large angular blocks, mixed with probably wind-blown sand, not less than 1,5 m thick, the rock-floor not being exposed.

Goodwin & Malan found cemented into the beach a rolled hand-axe and several flakes. They assigned these pieces to the M.S.A. Dreyer speaks of a doubtful hand-axe.

At Tonnelgrotte within the area of Mossel Bay is a cave with notch at 18 m (259).

There are traces of an 18-metre terrace at Fransmanshoek (150; ridge-crests, cliff and small cave) and Voëlklip just west of Gouritz Mouth (114). At Duineplaas, at the head of the Gouritz estuary, is what appears to be the gravel filling of an eustatically incised trench (109). The surface of the pebbles is at 18 m S.L. and is overlain by a little grey sand. The section exposed on the road-cutting is

S.L. 18–15 m	red riverine sand with some pebbles;
15–12 m	red probably estuarine pebbles, some laid;
12–below 9 m	grey-yellow riverine sand with a few pebbles.

In the gravel I found two unrolled uniface hand-axes (NM 70/2, fig. 9 2–3) and a few broken artefacts.

Estuarine gravels on a platform at 18 m are exposed on both banks of R. Kafferkuils close to Stillbay (123, 126). Behind Infanta is a fragment of a terrace at the same height (016). At Noetsie are two large caves with floors at 15 m and rising inwards, which are probably marine (025).

The Minor Emergence

Krige records only a single raised shoreline of his Minor Emergence, which he measures at 25, 20 and sometimes fewer feet (7½ and 6 m). Exact measurements are difficult to take owing to the difficulty of fixing M.S.L., and the feature which Krige measured varies: the surface of a beach or the back of a cave, both higher than the cliff-base or notch which I have tried to identify; or the surface of an estuarine or lagoon bed which is lower. I have explained in section I (Davies, 1971: 196) the method which I have tried to follow.

Krige (1927: 66) records in a few places what he calls a resting stage in the Minor Emergence, at 12–14 feet (3½–4 m), sometimes less.

Subsequent workers have assumed the Minor Emergence to be 7–8 m. This figure is derived ultimately from Zeuner's (1946: 128) Late Monastirian figure of 7½ m.

My observations suggest that the Minor Emergence consists of two stages, at 9 m and 6 m, probably separated by a regression; figures of 7–8 m may belong to either of these stages. Krige's 'resting stage' I consider to be a third transgression to about 3½ m, holocene and to be discussed in section VI.

I shall first list sites in the southern Cape where I observed both the 9-metre and the 6-metre platforms on neighbouring traverses. This list does not include lagoon-beds, many with Swartkops-fauna, whose surface is usually above 6 m, so they presumably belong to the 9-metre transgression.

Kasuka Mouth, 33°39′S 26°44′E.

There appear to be calcified estuarine sands on rock-cut terraces at 6 m and 9 m (623–4; Haughton, 1926).

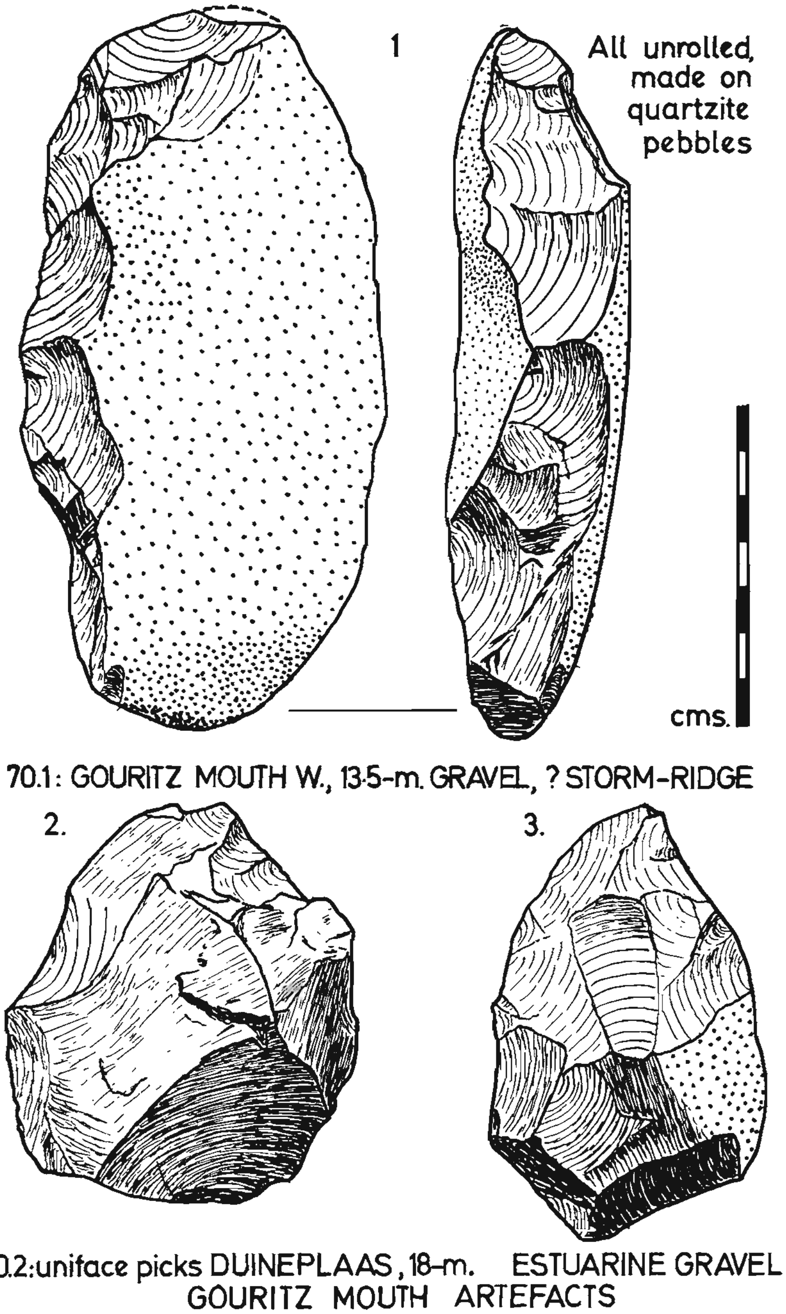

1
All unrolled, made on quartzite pebbles
cms.
70.1: GOURITZ MOUTH W., 13·5-m. GRAVEL, ? STORM-RIDGE
2.
3.
70.2: uniface picks DUINEPLAAS, 18-m. ESTUARINE GRAVEL
GOURITZ MOUTH ARTEFACTS

Figure 9

Kenton-on-Sea, 33°41'S 26°40'E.

Mountain (1962) claims a 9-metre terrace at the Kariega bridge, which I could not identify (620). There may be a platform at the same height incised into Carriage Rock, the calcified dune at the mouth of Bushmans River (611). The dune contains terrestrial shells; Mr Kilburn identified *Achatina zebra* and *Tropidophora ligata*. Parr (1958) noted a very few pleistocene foraminifera.

The existence of a 6-metre level is uncertain. On the Bushmans River estuary there is a fragment of rock-platform at 1,5 m M.S.L., covered by pebbles and water-laid sand to at least 5½ m (612; Mountain, 1962: fig. 10; p. 250).

Humewood, Shark River, 33°59'S 25°39'E.

Old accounts mention a fossil beach at Shark River, Port Elizabeth (524). Local informants are unanimous that this is the present Happy Valley, Humewood. Johnson (1903) describes in a disused railway-cutting 400 yards (365 m) from the right bank of the stream a quartzite terrace planed into ridges like those on the modern shore; cemented to it quartzite pebbles and heavily rolled shells, living species, the commonest being *Cominella porcata* (= *Burnupena cincta*). Though no altitude is given, from a section-drawing it may be calculated that the exposed cliff was at not more than 5 m M.S.L. Above the beach was cemented dune with shells of *Achatina zebra*. Towards the stream the quartzite platform was replaced by dune-rock. Near the top of the dune were archaeological sites with stone flakes and molluscs. Johnson's terrace is probably the lower terrace described by Stow (1871); he speaks also of shells, quartzite fragments, bones, teeth and root-casts cemented on mounds of dune-sand at 18 m, probably the midden mentioned by Johnson.

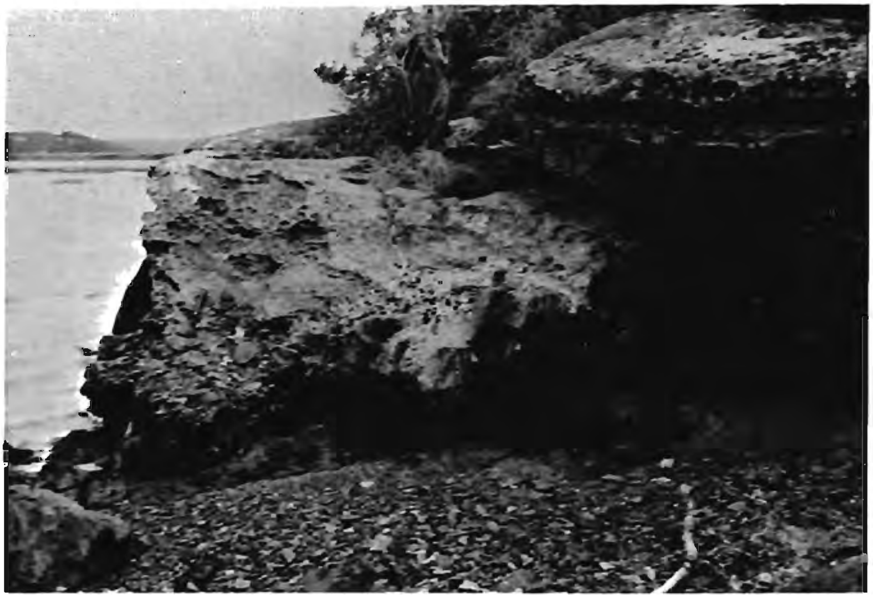


Figure 10
Bushman's River estuary east bank, pebbles and beach-sand on low rock-platform, site 612.

Johnson's site was some 500 m from the exposure on Humewood Esplanade (526), on the other side of Happy Valley, and his altitude suggests underwater beds. Krige (1927: 60) and Haughton (1937*a*) record a beach-deposit at 6,6 and 6,0 m overlain by aeolianite. I measured the height of the rock-platform as 9 m M.S.L. It seems that with the widening of the Esplanade the present exposure is farther inland than that seen by Krige and by myself in 1953, and so higher up what was probably a single beach-platform. As no cliff is recorded for this beach, it does not seem that there is evidence for two transgressions to 6 m and 9 m.

Jeffreysbaai, 34°03′S 24°55′E.

The exposure where Krige collected shells was probably in Williams Street at 10 m M.S.L. (429). There is a calcified beach-platform without cliff at 9 m in Ferreiratown (431); Haughton (1937*a*) gives 6 m, further seaward on the platform. The shell-fragments are unidentifiable. In Jeffreysbaai there is almost certainly a lower platform at 6 m (430), with sharp rise to the 10-metre level.

Kromme Mouth, 34°08′S 24°48′E.

On the north bank are rock-cut terraces at 9 m and 6 m (414–15). On the south bank a terrace at 9 m, covered by one metre of pebbles, is incised into the 18-metre terrace (413).

Seal Point, 34°13′S 24°50′E.

At the village there can be identified narrow terraces with notched cliffs at 9 m and 6 m (419–20).

Oyster Bay and White Point, 34°10′S 24°39′E.

There are terraces with cliffs at 9 m and 6 m (403, 437). On the 6-metre terrace is crumbly beach-rock, overlain by poorly cemented aeolianite.

Tzitzikama East, 34°06–09′S 24°23–7′E.

The beach on the floor of the lower cave at Clasie's River is said to be at 7,8 m M.S.L. (406; J. Wymer, pers. comm.). At Huisklip near Tzitzikama Point Krige (1927: 59) records a planed rock-surface at 6,3 m, overlain by aeolianite in which a tunnel had been eroded (403). This suggests more than one sea-stand. The platform covered by well-cemented dune is likely to be older than a Würm interstadial; but the tunnel might belong to this stage.

Hengelaarskroonstrand, 34°04′S 24°13′E.

On the Skietgate stack there are terraces at 9 m and 6,6 m, each cliff incised into a higher terrace (410–1). At Oubosstrand (416–17) there are probably terraces at these altitudes, as well as small caves on the east bank of the Grootrivier.

Stormsrivier Mouth, 34°01′S 23°53–4′E.

There is a terrace with cliff-base at 9 m at Gougate (313), probably another with cliff concealed at Swartrif (310), and a cave at the same altitude in Mooi Bay (305). At Gougate there is also a terrace with cliff at 6 m, and perhaps at Swartrif (311). The floor of one of the caves in the Storms estuary appears to be at less than 7,5 m (303); but measurements in these caves may be inaccurate owing to rock-fall, accumulation of debris and rock-erosion as the ocean fell from its maximum.

Plettenberg Bay, 34°01–06'S 23°24'E.

East of the Keurbooms mouth the only trace of an old shoreline appears to be at 9 m (323; probably 328 but cliff-base masked). South of the Bietou estuary the evidence is unsatisfactory. An apparent planed surface of Beacon Island at 9 m, incised by a terrace and cliff at 6 m (337–8), may be no more than the product of building activities. I could not identify a cave at 7 m (Krige, 1927), but I saw one at 8,3 m at Robberg Gap (342–3). The rock-floor at Ghwanogat has not been measured.

Therefore the most reliable evidence is the thick shingle-bar on both sides of the Keurbooms estuary. It seems to be a single feature, composed of derived cretaceous pebbles worked to a bar and then incised. There is some difference in the recorded altitudes. The surface of the western stretch (335) I measured as 9 m, Krige (1927: 58) 8 m (perhaps above H.W.M.), Macfarlane (1958) as 6–9 m at Sunnyside. On the east bank near Hotel Frederick, Krige gives the surface of a poorly rolled conglomerate as 8,1 m, I measured 7,5 m, while Mortelmans (1945) claims a beach at 4,5–6,0 m all along the foot of the hill at sites which appear to be no longer exposed. A number of artefacts has been found in this gravel (fig. 13; below p. 245).

Noetsie, 34°05'S 23°08'E.

There is a well-marked terrace with cliff and some pebbles at 9 m (348). There is probably a terrace at 6 m (349); Krige records a cave at 5,5 m at Noetsie, and a double arch with maximum floor-height at 6,5 m at Mew Stone Point 2 km to the west (pt. 121; 352).

Knysna, 34°05'S 23°04'E.

Krige records caves in the Western Head with floors at 6 m and 10,5 m (360). On the East Head I saw caves at 6 m and 9 m (358–7). There is a terrace-fragment with notch and cliff at 6 m in Coney Glen (354). Mortelmans (1945) found a 6-metre beach in the lagoon (now destroyed; below p. 246).

Wilderness, 33°59'S 22°35'E.

Krige records a terrace cut in the cliff at 4,5 m (212). Owing to modern developments this cannot now be seen, and talus and dune have covered marine remains such as beach-rock and pebbles. The terrace was probably roughly at the present road, and according to my measurements would have been rather higher than 4,5 m. It was probably cut by a 6-metre sea in a bay which has become estuarine lagoon. This sea was presumably lower than the sea which laid down a beach, without cliff, at 6,0–7,5 m on Eiland Vlei (210). This beach contained Swartkops-fauna (below p. 256; Martin, 1962) and apparently separated two phases of dune, but I could not recognize the site from Martin's photograph. I did however see a rock-spur at about 9 m near the railway-crossing at the west end of the lake, which seemed to be a fragment of terrace. Krige records at this lake also an irregular terrace at 4,5 m.

Pacaltsdorp area, about 34°03'S 22°19–34'E.

I observed remains of a 6-metre terrace in several bays along this steep coast (215, 214, 219). In the Gwaing estuary is a cave at 9 m (222). At Glentana are ledges with notches and caves at 9 m and 6,3 m (229, 230), mentioned by Krige. Near the mouth of the Groot-

Brak River Haughton (1937*b*) mentions a beach without cliff at 7 m (233), which I was unable to find.

Mossel Bay, 34°11'S 22°09'E.

Around the promontory are caves at 9 m opposite Tonnelgrotte (260); at 6 m near Die Bakke (252; Dreyer (1934), I did not find), Tonnelgrotte, a ledge thought by Krige to indicate that the cave had been cut in two stages (261), and Pinnacle Point (263, recorded by Krige; I did not reach the place; back at 7,5 m).

Gouritz Mouth, 34°21'S 21°48–52'E.

There is a well-marked terrace with pebbles and cliff at 9 m at Voëlklip (115). A storm-ridge at 13,5 m (110), barely exposed on the riverside road, probably belongs to the same S.L.; a slightly rolled hand-axe was found in it (NM 70/1, fig. 9 1; see below). Up R. Gouritz is an estuarine terrace at 9 m rising to 15 m, incised into sands (112).

There is however no satisfactory evidence for a 6-metre level. The storm-ridge on the road at Voëlklip and Gouritz Mouth is at 5,5–6,0 m (116), and almost certainly belongs to a lower S.L.

Stillbay, 34°22'S 21°25'E.

There are terraces on R. Kafferkuils at Stillbay and to the west at Grootjongensfonteinstrand at 9 m (124, Olive Grove, estuarine; 128, Piet Rogsbaai Point, cliff concealed; 132 with cliff) and about 6 m (125, Stillbay East, at 5,5 m; 129, Piet Rogsbaai, at 6,2 m, cliff removed by gully).

Duiwenhoks Estuary, 34°21'S 21°00'E.

There is a marine terrace carrying 30 cm of small flattened pebbles up to 8,4 m (148); it is incised into dune-rock. There is a terrace also at 4,5 m, cut in shale and carrying a few pebbles (149); if it were part of the estuary-floor, S.L. would have been higher.

Breë Estuary, 34°24'S 20°50'E.

There is evidence only for a terrace at 5,7 m (008) in the estuary, with cliff just behind but concealed. This is the highest level at which the hard sandstone at Witsand (010, see below p. 260–1) is exposed.

Arniston Point, 34°40'S 20°14'E.

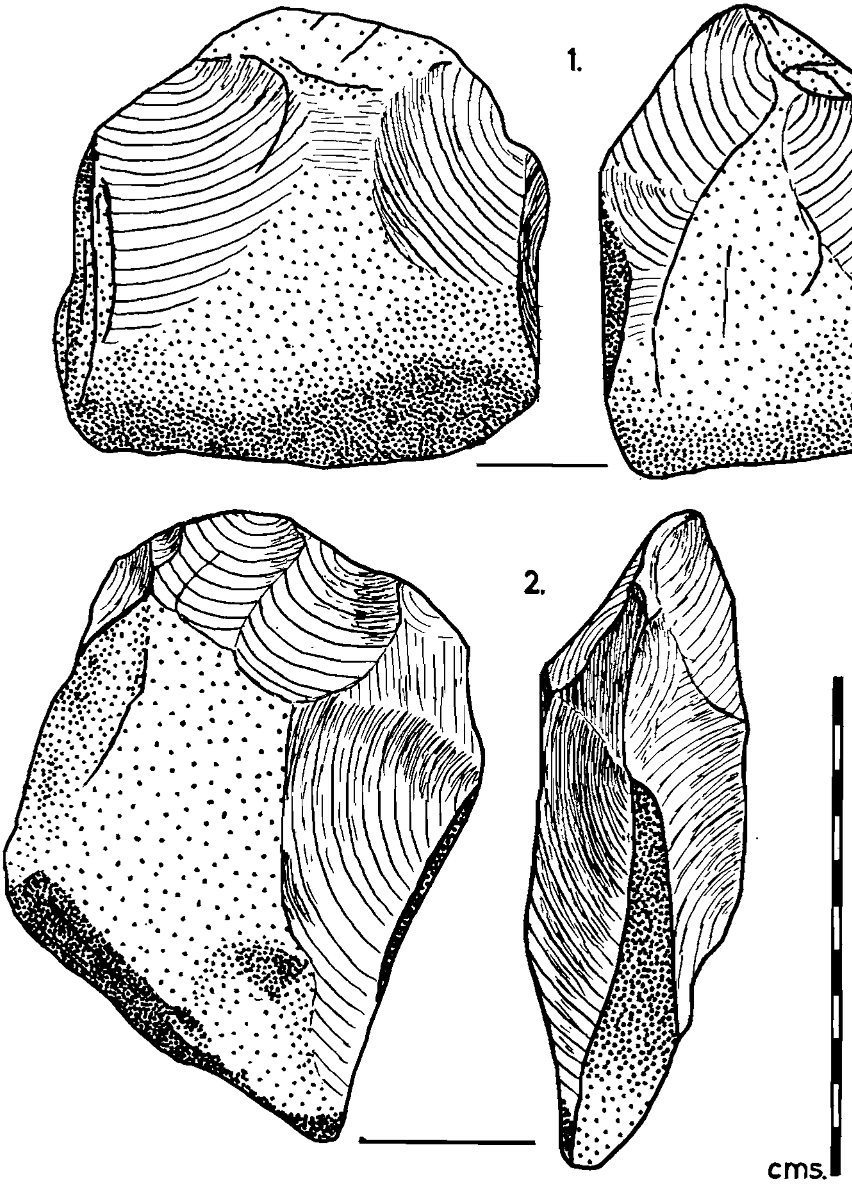
There is a cave in dune-rock at 6 m, and probably a notch at 9 m (028, 029).

Artefacts associated with the Minor Emergence

Artefacts on a dune which overlies a fossil beach or marine terrace give only a vague *terminus ante quem*, and may be very much later than the beach; e.g.

701 Rocky Point, apparently from a calcified dune now eroded, overlying a lagoon-deposit which on a radiocarbon date is not more recent than intra-Würm, midden-material with flakes and shells.

562 Coega Saltworks (Salnova), in the base of a dune overlying beds with Swartkops-fauna up to 7,1 m, unrolled Late Acheulian or Fauresmith pieces (to be published with excavation-report).



69.25: KLEINEMONDE, 9-METRE BEACH. ROLLED QUARTZITE.

Figure 11

537 King Neptune, from a crust on a fossil beach up to not less than 6 m, pebble-flakes perhaps L.S.A.

558 Redhouse south pit, from 22 cm above the base of red sand which overlies lagoon-beds (see below) and rock, at over 6 m S.L., flakes of Mossel Bay type (NM 69/18, fig. 6 4–5). The lagoon-beds probably belong to the 9-metre sea.

427 Cape St. Francis, the dune covering the 18-metre terrace (above p. 232) spreads over the 9-metre terrace and carries unrolled M.S.A. (fig. 6 1–3).

Artefacts associated with the 9-metre S.L.

711 Kleinemonde, on what had been a sandy beach with cliff-base at 9 m, a hand-axe, a chopper, a flake and a flaked split pebble, all lightly rolled; NM 69/25, fig. 11.

Near Coega Station Krige records a terrace at 6 m above the flood-plain. Breuil collected, perhaps from this site, on the old Grahamstown road rolled Late Acheulian (Jhb 13/38/4–5); and records more specifically rolled Acheulian from a gravel at 5,4–7,8 m above river 200 m behind the hotel (Jhb 90/48).

528 Swartkops Mouth, beach up to 7,5 m, probably part of 557 which contains Swartkops-fauna (fig. 12); some heavily rolled broken pebbles which might be artefacts, and from its surface poor unrolled M.S.A. flakes.

Kabeljous Mouth. Traces of calcified beds containing very few valves of *Dosinia hepatica*. Surface appears to be about 4 m M.S.L., but they look pleistocene; the exposure may be far from their top. On them a few unrolled atypical artefacts, probably M.S.A.

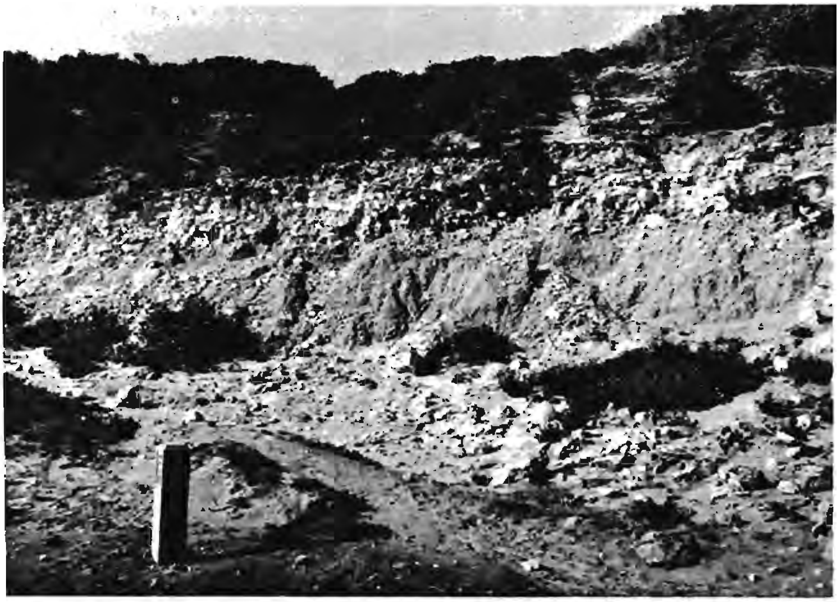


Figure 12
Swartkops mouth left bank, 6-metre beach, site 528.

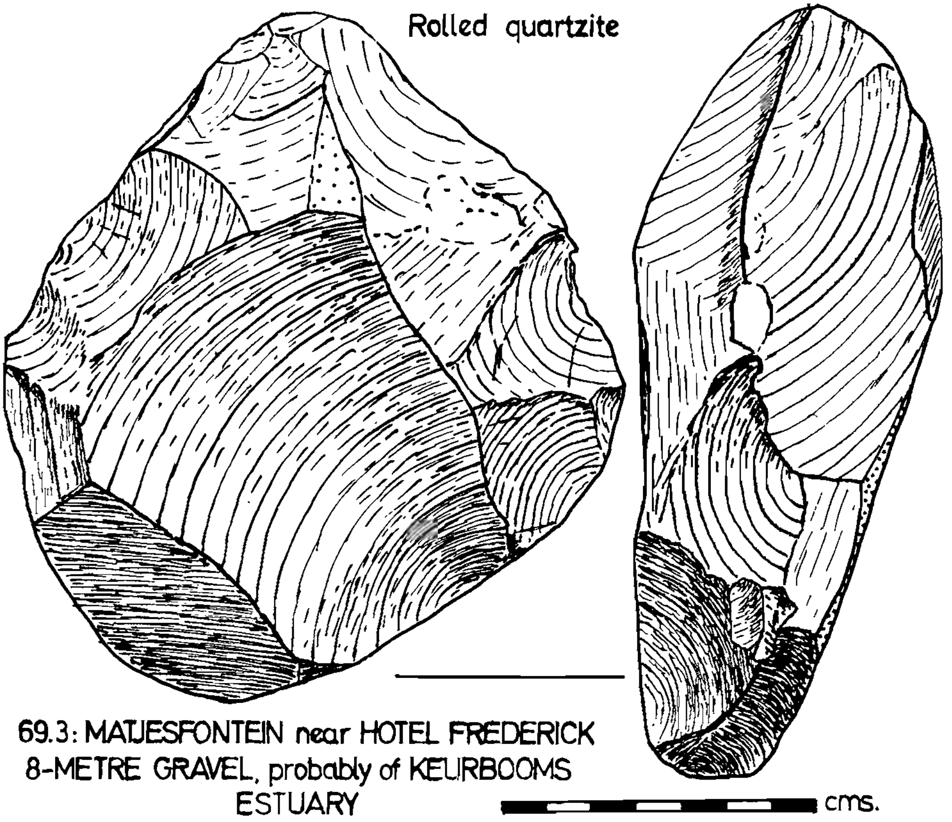

Rolled quartzite
69.3: MATJESFONTEIN near HOTEL FREDERICK
8-METRE GRAVEL, probably of KEURBOOMS
ESTUARY
cms.

Figure 13

406 Clasie's River, M.S.A. directly on a beach at 7,8 m in the lower cave (Wymer, pers. comm.).

335 Keurbooms and Bietou estuarine bar and gravel with surface up to 9 m:

I recorded in 1953 but did not collect very rolled choppers and a lightly rolled core from a large flake, in the gravel-bar on the right bank just south of the Bietou bridge.

Macfarlane (1958) claimed rolled M.S.A. flakes from near the surface of the same bar; these I have not seen or controlled.

Mortelmans (1945) recorded from the left bank unrolled Stellenbosch B and rolled Stellenbosch A; in more detail he lists and illustrates possible rolled pebble-tools, a crude rolled pick and two flakes; lightly rolled a large uniface hand-axe and several flakes. In Johannesburg are two Late Acheulian pieces, lightly rolled (Jhb 68/43; the Early Acheulian, numbered 74/43, I could not find). Mortelmans apparently collected from quarries which are now filled or destroyed, sites 1 9 and 11 (Jhb 68/43, 74/43, 76/43).

I collected in a large new quarry just west of Hotel Frederick a heavily rolled large hand-axe, perhaps Early Acheulian (fig. 13; NM 69/3); a rolled chopper, not entirely convincing; and pebbles whence one or two flakes have been removed, unconvincing as this gravel must have undergone considerable abrasion by natural forces. The heavily rolled pieces which seem typologically archaic, especially those from the east bank where the gravel is immediately at the foot of a steep scarp, may be derived by erosion from terraces up the hill and not associated directly with the 9-metre gravel.

243 Klein-Brak Estuary; in lagoonal beds up to 6 m M.S.L., probably laid down in the 9-metre sea, Rogers recorded a flake of Mossel Bay type and heard of subspherical pounding-stones (Rogers, 1906; Péringuey, 1911: 80). Goodwin (1930) considered that these pieces had lain in the humus above the shell-beds.

At Causeway (246) a sub-angular river-gravel on a dipping platform at 9 m is probably contemporary with the lagoon-beds to seaward. On it I found one unrolled flake, perhaps M.S.A. See also below p. 257.

104 Misgunst, on a pebble-beach at 9 m unrolled cores and other pieces of M.S.A. type.

110 Gouritz Mouth, in a storm-ridge up to 13,5 m a lightly rolled hand-axe, fig. 9 1, NM 70/1.

124 Olive Grove, Stillbay, on a terrace at 9 m, cut partly in rock and partly in a filling of river-gravel, an unrolled hand-axe.

Artefacts associated with the 6-metre S.L.:

541 Hougham Park, on a platform of calcified beach-sand traceable up to 6 m S.L. without cliff, an unrolled pyramidical core of M.S.A. type.

Knysna, on a 6-metre beach exposed east of Royal Hotel, inside the lagoon, an unrolled hand-axe, Jhb 77/43 (Mortelmans, 1945).

It will thus be seen that, except for the pieces from Olive Grove and Coega Saltworks, the Late Acheulian on the 9-metre beach is lightly rolled. This agrees with the evidence from Natal and the Ciskei. Rolled hand-axes were found on the 9-metre terrace at Gibraltar Rock (709; Davies, 1971: 195) and in the river-gravel close to the mouth of R. Hluhluwe (Natal 814; Davies, 1970: 433), while on and above deposits of the same stage unrolled Sangoan pieces occur (Natal 814; Natal 946, Mgeni bridge, see Brien (1935); pebble-chopper from river-gravel 10,5 m above present stream at Hole-in-the-Wall, Transkei X77). It therefore seems reasonable to associate the 9-metre S.L. with the Eem interglacial.

The 6-metre terrace is more problematical. The unrolled hand-axe from Knysna may be post-Acheulian or have been transported to the find-spot. Very late Acheulian rolled, probably really Fauresmith or M.S.A., occurred at Ngane (Natal 025; Davies, 1970: 435); lightly rolled Sangoan in the beach at Reunion (Natal 970); Sangoan said by Mr R. C. Walsh to have been rolled and unrolled on an estuarine deposit at Jacobs (Natal 963; I have not seen these pieces); at Tiger Rocks smoothed flakes, whether water-rolled is uncertain, claimed to be M.S.A., cemented to the base of the aeolianite overlying a beach which Beater puts up to 8,4 m, but he has no evidence for so high a level at this point, and I measured its exposed top at between 6 and 7 m M.S.L. (Natal 03; Beater, 1967).

More satisfactory is the evidence from East London, discussed in section I (Davies, 1971: 195). The low-level beach close to Nahoon Point (707) must be pleistocene. Wind-blasting of M.S.A. artefacts lying on it indicates that they had already been deposited at the time when the overlying dune was forming; and the date for this dune is intra-Würm (29090 $\pm{}^{410}_{390}$, SR–83). This date was obtained from shell-fragments, some perhaps contemporary land-snails, others blow up from the shore. The fossil beach now exposed must therefore have been exposed about 30000 B.P. It could be part of a much older beach, which may or may not have been covered by dune which was subsequently completely eroded. But the evidence from Blind River (752), not more than 1 km to west, indicates that a gravel-bed at 6,6 m S.L. was laid down after some phase of the M.S.A. This evidence for an independent intra-Würm transgression could be made watertight only with the discovery of the cliff of the Nahoon Point beach, assisted by isotopic dates not for the overlying dune but for the incorporated beach-rock; but it is already strongly suggestive.

Fauna associated with the Minor Emergence

Little fauna has been found on low-level beaches east of Great Fish River; but many sites are known in the southern Cape. All probably belong to the 9-metre transgression; none can be proved geologically to be associated with the 6-metre sea, and the evidence for such association rests on two radiocarbon-dates which are not entirely reliable and will be discussed below.

There are two groups of fauna, which I consider contemporary. Collections from most open beaches have yielded only species living in the area today. One or two may not have been identified recently quite so far west as the fossil beach; but as much remains to be done on the modern molluscs of South Africa, this may not be significant.

The other group is the Swartkops-fauna, which comes almost entirely from estuarine beds with surface usually at or above 6 m M.S.L. These must be assigned to the 9-metre or occasionally to an older transgression. Only one site is an open beach, at the mouth of an estuary in which also the fauna occurs; significant species are rare at the top of this beach, commoner lower down when the start of the regression would increase the current of the river and cause erosion of the estuarine beds. In addition to modern species, the Swartkops-fauna comprises a few which are extinct, such as *Cerithium rufonodulosum*, *Cantharidus fultoni fultoni*, *Monilea obscura ponsonbyi*; or today live in waters markedly warmer than at the sites in question, such as *Pitar madecassina*, *Tapes sulcaria*, *Paphia textile*. Some claimed warm-water species have been recently found to occur still in the areas where found fossil (cp. criticisms by Barnard (1962: 180) of Schwarz (1909)). The warm-water fauna of the South Cape may invite comparison with the contemporary warm-water *Strombus*-fauna of the Mediterranean.

I have set out the fauna from the two types of site in separate tables. At the top of each vertical column is the site-number, referring to the key below.

Mr Kilburn has identified my collections; other names refer to published papers. Older identifications, especially by non-malacologists, are not always reliable. I have taken Mr Kilburn's advice in modernizing out-of-date names. Where he considers that the name given is almost certainly a misidentification, I have used two ??; if he cannot identify the name used, I have put three ???. A single ? indicates a query by the identifier. The South African species previously recorded as *Tellina madagascariensis* is now separated as *T. alfredensis* Bartsch, the true *T. madagascariensis* Gmelin being considered a West African form. However, as the latter does in fact occur in some South African deposits, it is impos-

TABLE 1

MINOR EMERGENCE, FAUNAL LIST; OPEN-SHORE SITES

Species	701	711	631	601	537	524	429	265
Afrocominella elongata						×		
Amblychilepas scutellum	×						×	
Ancilla fasciata					×	×		
obtusa		×	×					
sp.				×				
Argobuccinum argus							×	
Assiminea bifasciata					×			
Barbatia obliquata			×			×	×	
Bullia annulata					×	×		
callosa	×	×		×			×	
digitalis		×			?	×	×	
laevissima		×				×		
pura							×	
tenuis				×				
Burnupena cincta	×	×				×	×	
lagenaria	×	×	×				×	
pubescens	×		×				×	
Cerithium vulgatum ???						×		
Charonia lampas pustulata		×		×				
Chlamys cf. *tinctus*							×	
Choromytilus meridionalis						×		
Clionella cf. *kraussi*							×	
rosaria						×	×	
sp.				×				
Conus infrenatus						×		
tinianus						×		
sp.			×	×				
Crassostrea margaritacea		×					?	
Crepidula aculeata	×		×				×	
porcellana	×				×	×	×	
Cymatium africanum		×	×					
doliarium			×			×		
klenei	×						×	
parthenopeum							×	
Cypraea capensis	×	×				×		
Demoulia abbreviata						×		
retusa						×		
Diala infrasulcata					×			
Diodora calyculata							×	
Donax longissimus					×			
serra		×						×
simplex					×			
sordidus					×			
Dosinia hepatica		×		×				
lupinus						×		
Epitonium lamellosum	×							
Fissurella natalensis	×							
Fissurellidea aperta						×		
Fusus sp.							×	
Haliotis midae		×				×		×
Helcion pectunculus							×	
Kraussina rubra				×				
Littorina capensis ???						×		
Loripes clausus					×			
Lucina ? contempta							×	
Lyria africana				×				
Mactra glabrata					×			
Mangilia clathrata ???						×		
Marginella mosaica						×		
piperata	×	×				×		
Mytilus sp.			?				×	

TABLE 1 (*continued*)

Species	701	711	631	601	537	524	429	265
Nassarius capensis						×	×	
kochianus	×						×	
kraussianus						×		
Natica forata form. *queketti*						×	×	
genuana							×	
Nerita albicilla				×				
Ostrea sp.			×					
Oxystele sinensis	×			×		×		
tigrina						×		
variegata	×							
sp.							×	
Parvicardium turtoni							×	
Patella argenvillei	×					×		
barbara		×						
cochlear						×	×	
compressa							×	
granularis	×	×						
longicosta	×	×	×				×	
tabularis	×	×				×		
Perna perna							×	
Petricola bicolor					×			
Phalium labiatum iredalei	×					×	×	
zeylanicum		×						
Pitar madecassina							×	
Polinices didyma						×	×	
Pusia patula						×		
Pyrene albuginosa						×		
kraussi						×		
'*Rissoa*' *capensis*					×			
Rocellaria cf. *dubia*					×			
Schizodesma spengleri		×		×				
Siphonaria deflexa				×		×		
Thais capensis						×		
squamosa	×					×	×	
Timoclea arakana					×			
Trimusculus costatus						×		
Trivia ovulata	×							
Tropidophora ligata						×		
Turbo cidaris natalensis	×		×	×		×	×	
sarmaticus		×	×	×			×	×
Turritella carinifera	×		×			×	×	
Venerupis corrugatus	×						×	
Venus verrucosa						×	×	

sible to determine which species was the basis for early identifications of *T. madagascariensis*, which are therefore marked with?

701 Rocky Point, 33°30′15″S 27°08′00″E; det. Kilburn. Behind a boulder-beach, a shelly lagoon-deposit up to 6,5 m, probably once covered by dune; dated 31900 ± 800, Pta-416. Lagoon belongs at latest to the 6-metre transgression. Fauna modern from an open shore, no estuarine species.

711 Kleinemonde, 33°32′15″S 27°02′30″E; det. Kilburn; see fig. 11. Beach 2 m thick on a terrace at 9 m with cliff, cut in shale and cemented aeolianite at the road which crosses the two modern estuaries. Above the beach calcified dune, on which is midden, whence shells have fallen on to the beach; so no *Mytilids* were collected, and some *Patella* may be derived by contamination. All the smaller shells seem to belong to the beach, probably

all the oyster, of which none was seen in the midden. Fauna modern, from an open sandy shore near rocks, without estuarine species. Thus the estuary seems formed among dunes more recent than the beach.

631 Port Alfred, Turkstra Bakery, 33°35′52″S 26°53′38″E; det. Mountain (1962). Calcified beach of sand and pebbles 1½m thick on a platform at 6 m S.L., cut in hard aeolianite. No cliff visible, but the rapid rise of the beach suggests that it is close. Cross-bedded aeolianite overlies the beach, which is now much overgrown. Fauna and foraminifera modern (Parr, 1958). This may well be the top of the beach seen by Mountain (629) up to 3 m S.L. among dunes at the back of East Beach. This beach also yielded modern fauna. I could not find it, and exposures on East Beach are of planed rock-ridges without beach-rock. It is possible that some warm-water species reported as living around Port Alfred in fact were derived from this beach.

612 Bushmans River Estuary, 33°41′15″S 26°39′55″E. Mountain (1962) records calcified sand overlying a pebble-bed with shells, on the east bank 1,5 km from the mouth. The stratification (fig. 10) is:

Water-laid coarse calcified sands up to 5,5 m M.S.L., horizontally bedded, containing a few pebbles and no terrestrial shells
Pebble-bed and sands with *Ostrea*, 1,5–2,2 m
Shale-platform without cliff, 1,5 m.

Mountain says that the fauna is modern, but does not list species; so it is not tabulated here. The rock-platform up to 1,5 m may be exposed on the west bank (610), but there is no overlying calcified sand. This exposure may however belong to a later transgression.

601 Richmond Strand, 33°43′10″S 26°34′10″E; det. Kilburn. On a platform at about 9 m M.S.L., bed of calcified sand and pebbles 2 m thick overlain by dune, beside the stream-

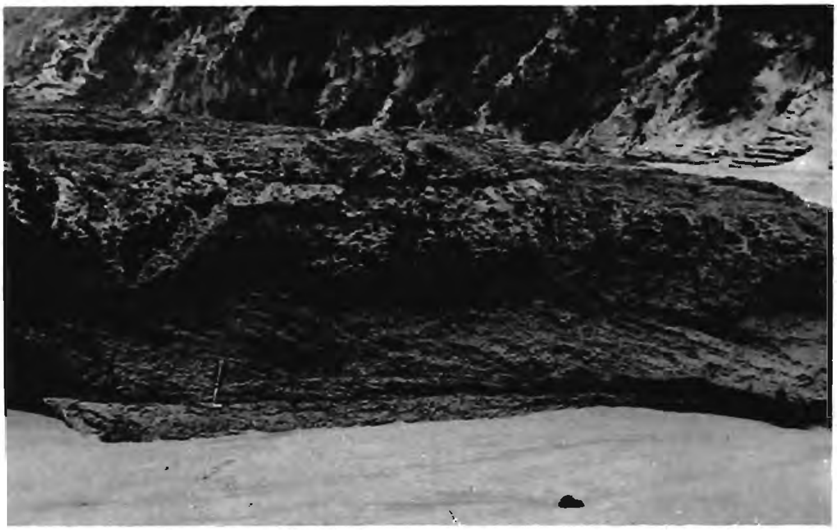


Figure 14
Gerickepunt, 1,8-metre platform incised into older dune, site 266; at Swartvlei end of the beach.

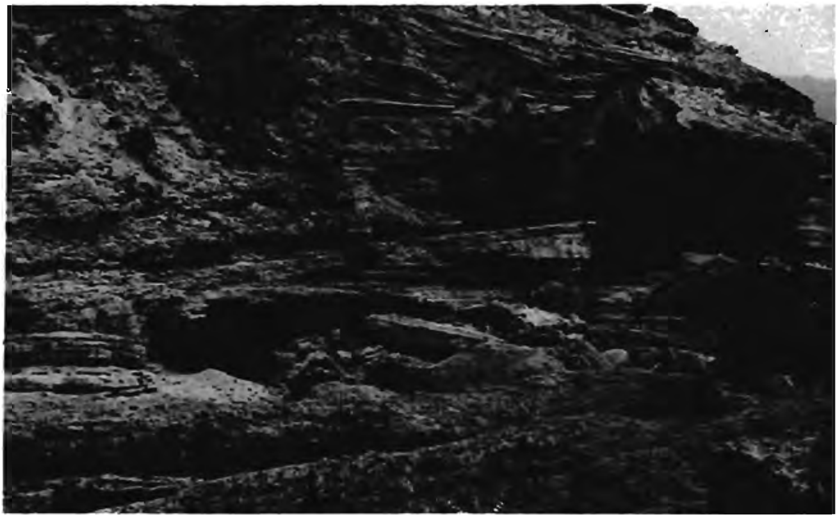


Figure 15
Gerickepunt, 1,8-metre platform and the later dune at the point.

crossing 2 km from the present mouth. This beach was sandy with rocks, close to the old mouth. Not many shells, all of modern species. A terrace at the same altitude is visible much nearer the sea at Nooitgedacht (602).

537 King Neptune, 33°48'30"S 25°40'45"E; det. Kilburn. Beach-rock traceable up to 6 m S.L. Loose pebbles may come from a midden on the crust. No cliff exposed. Fauna sand-dwelling. Kilburn considers that three species may indicate water warmer than today, as they are very rare below Natal: *Timoclea arakana*, *Donax simplex*, *Donax longissimus* (surprisingly abundant); *Diala infrasulcata* is probably extinct.

524 Shark River, Port Elizabeth, 33°58'45"S 25°39'08"E. For discussion of the site, see pp. 239–40. As the site has disappeared, I am not certain that it was an open beach, and the fauna may include Swartkops-species; in which case the site should be in Table 2. Shells copied from Johnson's list (1903); his *Cerithium vulgatum* may be the well-known *Cerithium rufonodulosum* of the Swartkops-fauna.

429 Jeffreysbaai, 34°03'20"S 24°55'20"E; det. Krige. Shelly beach-rock 60–90 cm thick on a rock-terrace at 8,4 m without cliff. One species not found below Natal, *Pitar madecassina*.

Bietou Estuary, 34°01'S 23°23'E. The shells listed by Schwarz (1899, 1909) came from dredging a channel and were not stratified, so have not been listed here. All are modern species.

265 Gerickepunt, 34°01'40"S 22°46'10"E; det. Kilburn. Cemented beach-sand with a few shells 30 cm thick, overlying aeolianite with root-holes near surface at 3,2–3,5 m and passing beneath a high dune little consolidated. Elsewhere (266; fig. 14–15) the junction of the two dunes appears to be at the 1,8-metre platform. No cliff exposed; the beach probably extends far beneath the dune. Fauna modern. Date of sample of *Donax serra*, Pta-444, 36 000 ± 2 200.

TABLE 2

MINOR EMERGENCE, FAUNAL LIST;
SITES WITH SWARTKOPS-FAUNA, MOSTLY ESTUARINE

	Older than 9-m terrace			Probably from 9-metre S.L.											
Species	567	568	553	562	558	559	551	528	557	523	KNY	208	210	243	241
Alaba pinnae				×		×				×	×	×		×	
Alvania fenestrata										×		×		×	
Amblychilepas scutellum								×		×		×		×	
Amiantis cf. *lilacina*											×				
Ancilla marmorata								×	×						
obtusa			×					×	×	×		×			
sp.					×										
Anodontia edentula	×	×	×	×		×			×	×	×	×		×	
Anomia ephippium												×			
Apolymetis orbicularis									×		×	×		×	
papyracea						×									
Assiminea sp.												×			
Balcis algoensis												×			
Barbatia obliquata														×	
Bulla ampulla						×			×	×	×	×		×	
Bullia annulata								×	×	×					
digitalis									×						
laevissima								×	×			×			
sp.					×										
Burnupena tigrina								×							
Calyptraea chinensis										×					
Cantharidus fultoni fultoni				×	×	×	×			×	×	×		×	×
Cerithium rufonodulosum			×	×	×	×	×	×	×	×	×	×	×	×	
Cerithidium fragrans														×	
Charonia lampas pustulata														×	
Chlamys tinctus												×			
Choromytilus meridionalis												×			?
Clionella sp.					×										
Colina pinguis			×					×							
Crassatella sp.								×							
Crassostrea cucullata											×				
margaritacea			×											×	
sp.								×	×						×
Crepidula aculeata			×					×				×		×	
porcellana									×	×	×				
Cryptomya philippinarum												×			
Cylichna sp.				×						×		×			
Cymatium africanum										×		?		×	
doliarium										×	×	×		×	
Diala infrasulcata				×							×	×		×	
Donacilla africana												×			
Donax burnupi										?		×			
Donax longissimus					×							×			
Donax serra			×					×	×			×			
Dosinia africana												×			
hepatica			×	×	×			×	×		×	×		×	
Fissurella mutabilis										×				×	
Fusinus ocelliferus									×						
Gastrana abildgaardiana			×						×	×	×	×		×	
Glycimeris connollyi			×									×			
queketti														×	
sp.								×	×						
Haliotis midae												×			
Hydatina sp.												×			
Lamya capensis												×			
Lanistina cuneata												×			

TABLE 2 (*continued*)

	Older than 9-m terrace						Probably from 9-metre S.L.							
Species	567	568	553	562	558	559	551	528	557	523	KNY	208	210	243	241
Lima fragilis										×		×			
nimbifer										×					
rotundata										×		×		×	
Littorina cf. *pintado*												×			
Loripes clausus	×	×		×					×	×	×			×	
liratula			×	×							×	×		×	
Lucina contempta												×			
Lutraria lutraria										×		×			×
sp.						×								×	
Macoma litoralis		×		×	×					×	×	×			
retrorsa												×			
sp. extinct					×	×									
Mactra capensis										×					
glabrata			×						×	×		×		×	
ovalina		×									×	×		×	
Marcia paupercula												×			
Minolia articulata												×			
Mitra sp.					×										
Modiolus auriculatus						×									
ligneus										×					
Monilea obscura ponsonbyi						×			×	×	×	×		×	
Nassarius kraussianus		×	×	×	×	×		×	×	×	×	×		×	
Natica genuana			×	×	×	×		×	×	×	×	×		×	
Odostomia jucunda												×		×	
Ostrea atherstonei														×	
Oxystele tabularis												×			
variegata										×					
Panope glycimeris										×				×	
Paphia textile					×	×									
sp.												×			
Papyridea papyracea														×	
Parvicardium turtoni										×	×	×			
Patella granularis									×						
Pecten ? benedictus erythraeensis											×				
maximus sulcicostatus									×	×		×			
Phalium labiatum iredalei										×				×	
zeylanicum			×			×								×	
Philine aperta										×		×			
Pholas dactylus										×					
Pinna squamifera												×			
Pitar hebraea											×				
Pitar madecassina			×						×		×				
Polinices didyma									×	×					
mamilla														×	
Psammotellina capensis				×								×			
Pseudactaeon albus										×	×	×			
Pupa sp.		×		×	×	×				×	×	×		×	
Pyramidella aganea												×		×	
Pyrene atrata				×											
Retusa truncatula											×				
Rhinoclavis kochi											×				
Ringicula turtoni				×						×	×	×			
'Rissoa' capensis				×								?			
Rochefortia ? similis												×			
Schizodesma spengleri			×												
Solen capensis		×				×		×		×		×			
sp.	×			×											
Stomatella sulcifera										×	×	×		×	
Sunetta ovalis (*Sow, non Martin*)												×			

TABLE 2 (*continued*)

	Older than 9-m terrace		Probably from 9-metre S.L.												
Species	567	568	553	562	558	559	551	528	557	523	KNY	208	210	243	241
Tapes deshayesii											×	×		×	
sulcaria						×			×			×			
Tellina canonica												×			
madagascariensis									×	?	?	?		?	
trilatera											×	×		×	
cf. *virgata*												×			
sp.				×											
Terebra suspensa												×			
sp.		×													
Thais capensis										×	×				
dubia					×				×	×		×		×	
Theora alfredensis											×	×			
Timoclea arakana												×			
costellifera												×			
Tivela compressa														×	
transversa												×		×	
Tomichia sp.												×			
Tonna variegata									×	×					
Tricolia capensis								×							
Triforis punctata ?? see Barnard (1962: 182)										×					
Triphora africana												×			
Turbo natalensis										×	×				
Turbonilla kraussi										×		×			
similans											×			×	
tincta											×				
Turritella capensis											×	×		×	
carinifera			×		×			×	×	×	×	×	×	×	
ferruginea ??														×	
*Ungulina alba**			×	×		×			×		×	×		×	
Ungulina alfredensis												×			
Venerupis corrugatus						×				×		×		×	
Venus verrucosa			×	×	×	×		×	×	×	×	×		×	
Vexillum capense										×					

* det. Prof. E. Fischer-Piette, Muséum national d'Histoire naturelle, Paris.

562, 567–8 Coega Saltworks (Salnova), 33°46′43″S 25°40′40″E; det. Kilburn. A pit 200 m east of the factory revealed three estuarine beds separated by terrestrial calcrete. No cliff associated; though it may be assumed that the Upper bed belongs to the 9-metre transgression, there is no evidence for dates of the Middle and Lower beds; one of them may belong to the 18-metre stage. Trial-excavations were carried out, but the material has not been sorted; no account is taken of it here. I have listed in this table only surface-collections. The beds extend along the east bank of the Coega estuary, where *Cerithium rufonodulosum* has been found. On the uppermost bed is red dune-sand containing hand-axes and a cleaver.

562 is the Upper bed, exposed at 7,1–6,3 m.

567 is the Middle bed, exposed at 6,0–4,47 m; shells very scarce.

568 is the Lower bed, below 4,47 m, base not exposed below 2,7 m; beds of shell, mostly not articulated, interspersed with sand-lenses.

Shell-deposits on R. Coega are mentioned by Barnard (1962), but there is no indication of site or level.

The shells recorded by Engelbrecht *et al.* (1962: 32 top) from Coega Saltworks appear to be collections from below S.L. in the Coega channel. These shells must have been derived from the raised beds at the side of the valley; but as strata would have been mixed in the erosion, the lists are valueless.

553 Cradock, 33°54′45″S 25°34′50″E; det. Kilburn. Beds on R. Papkuils described by Stow (1871), then concelaed, and revealed for a few days in 1969 in making the N2 road. The fauna suggests a sheltered bay near an estuary. It contains members of the Swartkops-fauna, though the altitude of about 13,5 m M.S.L. (data supplied by the City Engineer, Port Elizabeth) indicates that the beds belong to a S.L. higher than 9 m, probably to that of 18 m. The beds were later incised by a channel, in which was a peaty filling. Collecting among heavy road-machinery made it impossible to obtain accurate sections.

558 Redhouse, pit at head of the salt-pans, 33°50′42″S 25°34′15″E; det. Kilburn. Beneath 1,5 m of wind-blown sand, beds of estuarine calcified clayey sand with shells, giving out in the pit which must bestride the head of the former lagoon. Altitude could not be measured exactly, > 7,5 m. Probably from this pit and 559 came the shells listed by Barnard (1962). Large collections also in Port Elizabeth Museum.

559 Redhouse, pit at the turn from the main road opposite pt. 28, 33°50′30″S 25°34′00″E; det. Kilburn. Estuarine shelly sand with some articulated bivalves, up to 7,2 m, base not exposed. Probably the same beds as 558; there seem to be traces of them also at Redhouse station.

551 Redhouse, det. Geological Survey. Beach reported by Engelbrecht *et al.* (1962) at 9 m, 9,6 kilometres up R. Swartkops. Altitude and localization are wrong, site cannot be identified but may be part of the beds 558–9. Stow (1871) records a shell-bed at 7,5 m at Swartkops Bridge, which has perhaps been bulldozed, as have many dunes in this area.

I have no information on other sites in the Swartkops valley, viz. Coerney (Barnard), The Bight (Stow). Barnard's identifications are not always satisfactory, and his localisations leave something to be desired. For the beds at 12–15 m west of Redhouse see above p. 231.

Schwarz's collections (1909) came partly from sandy mud filling a rock-channel below modern S.L. This material must be derived from the raised beds, but was mixed.

528 Swartkops Mouth, 33°51′50″S 25°37′55″E; det. Kilburn; fig. 12. Surviving fragment of a beach-ridge on left bank of R. Swartkops close to the mouth, below Settlers' Bridge; rests on soft brown sterile sand at just under 6,0 m and about 1,6 m thick, apparently banked against a cliff. Calcified sand and shells are mixed with pebbles. Probably the same beach-ridge as Deal Party. (557), widely incised by R. Swartkops during a regression. Stow (1871) apparently saw the same beach, but puts at 0–1,8 m S.L.

557 Deal Party, 33°52′50″–53′00″S 25°37′20″E; det. Kilburn. The industrial area appears to be built on a curving beach-ridge about 500 m behind the modern shore. This ridge is sectioned only at the north end on John Tallant Road. Its crest there is at 5,1 m; but north of the road it rises to 6,5 m, and its original height in the built-up area is unknown. Its base is concealed. To landward the ridge sinks into a marsh at about 2 m S.L. Seaward the beach may be traced across the N2 road to near the modern shore. It is formed of sand and pebbles with layers of shell, and is heavily calcified. The fauna contains Swartkops-

elements; but *Cerithium rufonodulosum* is rare, being probably an estuarine species. The fauna belongs to an estuary and a sandy beach; there are no saxicolous species.

Stow (1871) probably saw exposures along this beach-ridge before it was built over.

523 The Creek, 33°55'00"S 25°36'40"E; det. Johnson (1903) and Schwarz (1909). Almost certainly the inlet at the south end of Deal Party, the mouth of R. Papkuils, called by Krige New Brighton Spruit. It is changed out of all recognition by modern works. Up the river may be the site called by Stow (1871) Ferreira's River, though his altitudes suggest that he may be describing the downriver continuation of the Cradock beds (553). Johnson describes a shelly limestone at > 4,5 m; according to Krige, the beds could be traced upstream to 5,7 m. No modern investigation has been made.

Gamtoos Mouth, Mouritzkraal, 33°56'55"S 25°01'43"E; det. Kilburn. Though most of the Gamtoos flood-plain has until recently been an arm of the sea, there are remains of older marine beds on a road-cutting away from the main channel close to Mouritzkraal. The cliff which bounded the former gulf ends a little above Vaalkrans, and from there to Mouritzkraal the road incises terrestrial red sands containing land-shells. Close to Mouritzkraal marine sands and silts are exposed for about 300 m. At about 4,5 m M.S.L. there is an unconformity in the section. Below this level are bedded silty clays, and on their surface a layer of pebbles and larger shells, mostly *Donax*. Above the unconformity are fine sands containing scattered *Assiminea*. The beds are overlain by calcrete at 9–10 m M.S.L., and they seem to be banked against a cliff cut into the Cretaceous, which also is planed to 9 m. Whether the unconformity represents two transgressions or a minor fluctuation is not clear.

The fauna is poor. There have been identified *Assiminea ? bifasciata*, *Donax serra*, *Dosinia hepatica* and *Loripes liratula*. Only the last may be typical of the Swartkops-beds. From the absence of typical species, it seems that the deposit is marine-lagoonal rather than estuarine.

Knysna, 34°02'10"S 23°02'25"E. Barnard lists fauna from raised shell-beds in the estuary. These beds have been identified by Tankard and myself around and behind the Total Garage, at the junction of road N2 and Rawson Street; I have added to Table 2 three species not listed by Barnard but identified by Kilburn from my collection. There is a gradual rise from slob-land just above H.W.M. near the railway to the National Road, which is at 2,5 m M.S.L. and has incised the beds. Owing to vegetation and modern terracing the exact height of the beds cannot be determined; it seems to be between 7 and 9 m M.S.L. They contain typical Swartkops-fauna.

208 Sedgefield, 34°01'S 22°47'E; det. Barnard and *ap*. Martin (1962). Estuarine beds up to 5 m, no cliff. Carefully explored by Martin by pitting and not now visible. Barnard's and Martin's lists differ slightly, so it seems that they examined the fauna independently.

210 Eiland Vlei, 33°59'S 22°38'E; det. Barnard *ap*. Martin. Martin (1962) records beach-rock at 6,0–7,5 m overlying a dune-cut platform and covered by dune. I could not find the exposure or recognize it from the photograph which Martin published. Hardly any fauna was identified.

242, 243, 247 Klein-Brak Estuary; det. Rogers and Barnard. All round the old estuary are lagoonal beds containing Swartkops-fauna. There are four principal exposures:

242 Rooiheuwel, 34°04'00"S 22°08'45"E (fig. 16)

243 Homestead, 34°03'40"S 22°07'50"E
Klipheuwel, 34°03'55"S 22°07'20"E
247 Barswel, 34°04'20"S 22°06'50"E.
241 see below.

The exposures are along a bank which is the degraded cliff of a lower transgression (244) to 3,3 m, forming the present flood-plain of the river. It is possible that beach-rock now being planed at 0,7 m M.S.L. along the shore at Klein-Brakrivierstrand (239) and Tergniet (237) is the outer part of the same beach. In this beach-rock I found no molluscs except oysters. It apparently rests on a platform cut in cretaceous beds.

I collected no shells from the Klein-Brak beds. The list in Table 2 is compiled from older collections, probably from the Homestead exposures (Rogers (1906) copied by Schwarz (1909), with additions by Barnard (1962)). Many have been collected by Mr W. Robertson of Homestead.

At Rooiheuwel I cleaned the section in a pit beside the road and measured as far as possible (fig. 16):

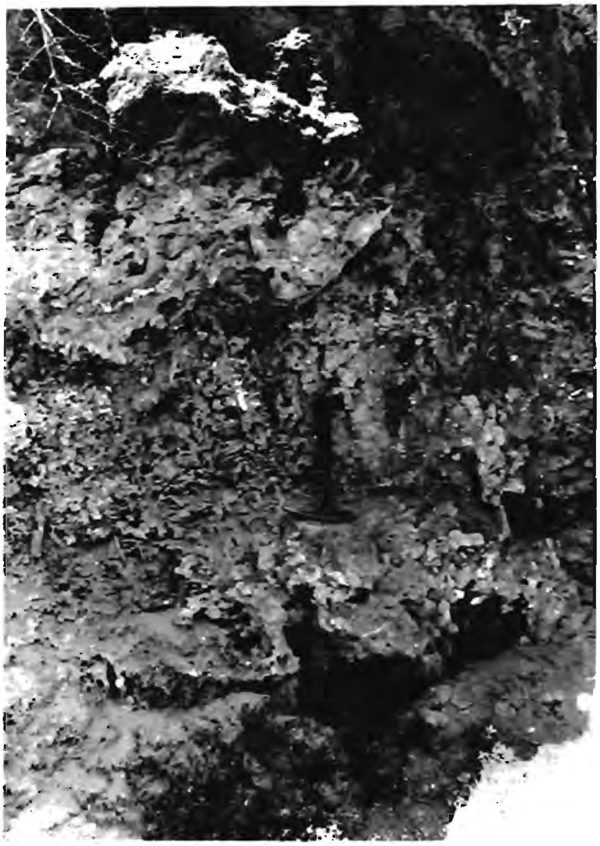


Figure 16
Rooiheuwel, section of beds of the 6-metre lagoon, site 242.

S.L. 7,2 m	surface
	red earth
6,6 m	surface of beds much gulleyed
	partly calcified beds with much shell
6,0 m	beds decalcified and without shell
5,55–5,3 m	irregular surface of calcified oyster-bed, many shells articulated
5,1 m	base of oyster-bed; patches of soft sand with *Mytilids* and *Patella*
4,8–4,5 m	grey sand with few shells, rubified on surface
4,4 m	bed of fragmentary shells
4,4 to base of exposure at 3,9 m, grey-white sand, grains rather angular, no shell.	

At Homestead the top of the bank is at 4,5 m, but the beds seem to extend landwards to about 6 m with no cliff. This is the altitude of the surface at Klipheuwel. A section down the field is required. The section at the bank is:

S.L. 4,5 m —thin layer of calcrete without shells
4,5–3,6 m—shell-bed mixed with fine sand; no shells articulated
below 3,6 m—fine brown sand with rare fragments of shell.

The sand is finer than at Rooiheuwel, suggesting derivation from dune.

241 Klein-Brak Mouth, 34°04′55″S 22°08′35″E; det. Haughton. Haughton (1937*b*) records a beach on a road-cutting on the left bank at 7,5 m. This appears to have been destroyed. One member of the regular Swartkops-fauna from it.

Haughton also records on the right bank below the railway-bridge (34°05′33″S 22°08′45″E) calcified pebbles and coarse sands capped by shelly beach-sand at 7–9 m M.S.L. His localisation indicates a deposit of conglomerate cemented by coarse shelly sand in a reentrant in the estuary; but this cannot now be traced above 2,4 m M.S.L., where it is concealed by dune and bush; nor can the cretaceous platform on which Haughton saw it resting now be seen, and the conglomerate seems to extend below M.S.L. Haughton may have traced it well up the hill; or he may have seen higher beds which I did not find, for above the bridge are slabs of rock (now inaccessible) which look like beach-rock and seem to mark the base of a cliff cut into the Cretaceous at about 9 m. What Haughton saw, if his estimated altitudes were accurate, must have belonged to the Minor Emergence. The conglomerates I saw could have belonged to the same stage, either deep in the beds or far out on the platform; or they may belong to a lower transgression, presumably holocene. The shell-beds extend only a short way; they are continued downstream to about 200 m from the modern shore by cemented sands and pebbles with few shells. The point where they stop may mark an old shore-line. Among the pebbles downstream I found a split pebble which appears to be an unrolled artefact (NM 72/3). Mr Kilburn has identified the following shells, all of modern fauna without typical Swartkops-species which are common upstream:

Barbatia obliquata
Bullia digitalis
,, *laevissima*
Donax serra
Littorina knysnaensis
Ostrea sp.
Polinices ? didyma
Tellina ? alfredensis
Thais capensis
Tivela ? dunkeri.

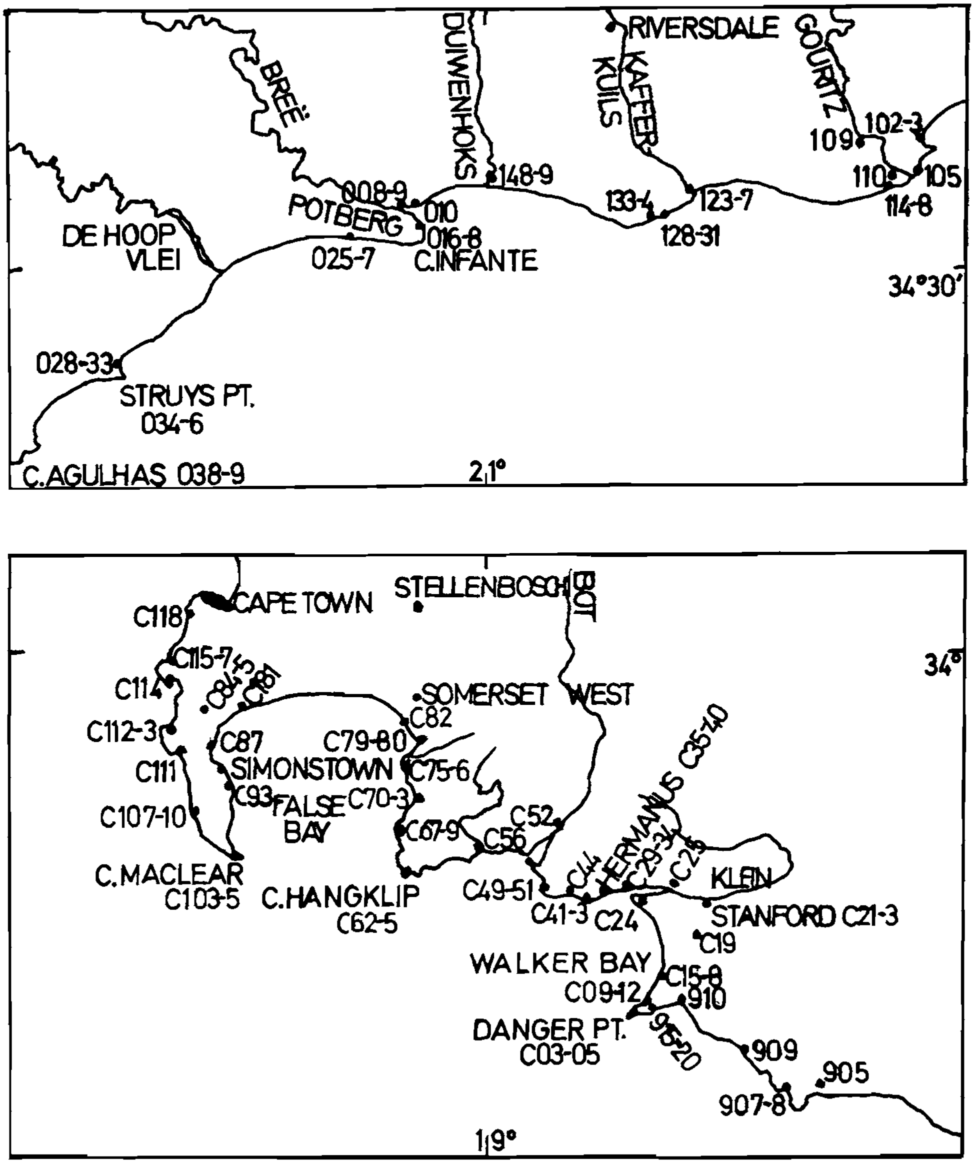


Figure 17
Map of the western part of the South Cape.

Low-level beds probably older than holocene

In places on the modern shore are exposed very hard beds of sand and pebbles which may have been planed recently but seem older than holocene; it is very difficult to extract from them fossils and pebbles which may be artefacts. Some have been supposed to be tertiary; but our increasing knowledge of the range of the Quaternary makes us hesitate about claims which do not depend on positive geological or palaeontological evidence.

Wybergh (1919) describes the coastal limestones in the Western Cape, what he calls the Bredasdorp Formation west of R. Gouritz. This comprises a hotch-potch of different rocks. Those below Riversdale are calcified dunes resting on a wide pebble-spread, the relics of Early and Middle Quaternary beaches, as described in part I of this paper (Davies, 1971: 218). Between Potberg and Cape Agulhas low dunes, in part cemented, overlie water-laid limestones. I have not seen the exposures in the Zoutrivier valley around De Hoop, which seem to be the most informative. Wybergh was unable to identify fossils from these beds to more than generic level; but he notes that two of the shells are not of modern form, and compares one to specimens from the Alexandria Beds, which however we now know to be largely pleistocene. At Arniston most of the shore-rock seems to be aeolianite. The promontory at the south end of the village (032) has been planed to 6 m without cliff; small pebbles incorporated in the planed surface may be the remains of a beach on older dune, like the beaches at Gerickepunt and Durban Bluff. Just south of the promontory a patch of ill-rolled boulders with a few shells up to 0,9 m S.L. appears to be the filling of a river-channel incised into aeolianite and grading to below modern S.L. (033). This may be the source of Barnard's molluscs from Arniston; I know no other shell-beds.

There are low-level beds also at the mouth of R. Breë, in the gap between the high dunes below Riversdale and the quartzite ridge of Potberg. The best exposure is at Witsand, just outside the river-mouth (010; fig. 18). A very hard limestone resting on shales can be traced among modern dunes up to 6 m; it may originally have been higher. It contains many angular and sub-angular stones and some fairly well-rolled pebbles; also many oysters. Wybergh (1919: 66) lists other shells, all modern species, probably from the same beds on

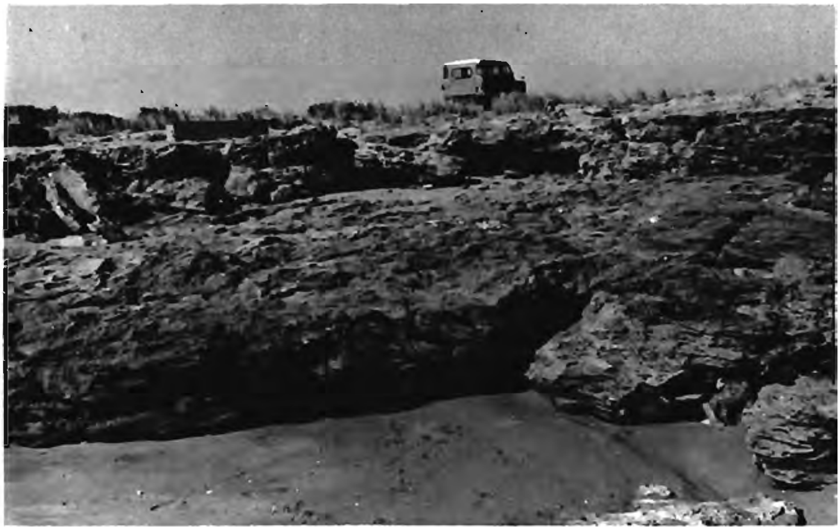


Figure 18
Witsand, calcified estuarine pebbly sand rising to 6 m, site 010.

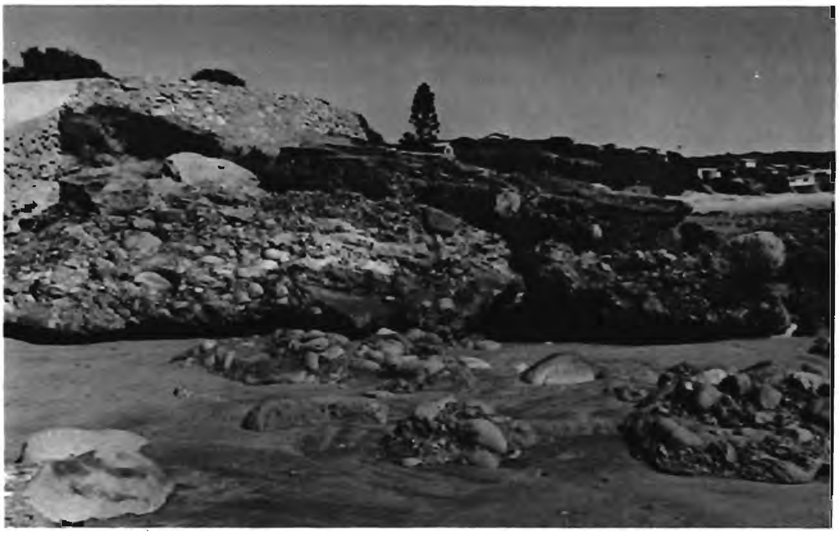


Figure 19
Vleesbaai, stratified beds of hard sand and conglomerate, sites 102–3.

the opposite bank of R. Breë, now not exposed. I found in the rock at Witsand also a piece of long bone and what appeared to be an unrolled thick quartz hand-axe; but I could not extract it to verify the identification.

The angularity of many of the pebbles precludes this cemented rock from being a marine beach. It may be an estuarine deposit from a transgression up to an unknown altitude. It is probably later than the 30-metre terrace of R. Breë, and assignment to the Minor Emergence is not unreasonable.

The southern Cape coast is probably too stormy for even cemented beach-rock to survive except in eastward-facing bays. The rock at Witsand is disintegrating under wave-action. The next exposure is at Vleesbaai. There is here a stratified deposit, mentioned rather inaccurately by Krige, and probably incised by holocene transgressions (102–3; fig. 19). The layers of fine sand may be derived dune-sand, so the whole section may belong to one episode rather than mirror a series of transgressions:

F At the corner of the bay, angular breccia cemented with red earth up to 5,1 m; probably Krige's 4,8-metre ledge.
E Fairly soft red dune with land-shells.
D Conglomerate of angular breccia with a little rolled material and pockets of marine shells, about 22 cm thick; probably Krige's 3,6-metre ledge.
C Fine cemented sand, planed at top to 3,3 m.
B Conglomerate of angular, sub-angular and well-rolled pebbles 0,6–1,2 m thick, with patches of marine shells; probably Krige's 2,4-metre ledge and extending seaward into the intertidal zone.
A Fine cemented sand exposed up to 2,1 m S.L.

The water-laid deposits appear to be lagoonal or estuarine. The cement is so hard that

I could extract no shells. Many of the large pebbles in D have percussion-cones, which may be modern. In both B and D were slightly rolled pieces suggestive of small hand-axes and flakes; but I could extract none of them to control them. The deposit is more likely to be quaternary than tertiary, and suggests comparison with Witsand.

East of Maitland Mouth, Haughton (1928) records a beach with flattened pebbles at 3 m H.W.M. cemented to rock (507). There is a planed terrace on the modern shore, on to which fragments of very hard beach-rock are cemented; the maximum altitude that I measured was 3 m M.S.L. No cliff is exposed; the hardness of the beach suggests a pleistocene date; it may belong to one of the Minor Emergence levels.

At Hougham Park most low-level beaches are incised into probably Late Pleistocene aeolianite; but at the east end of the estate (565; 33°45'30"S 25°45'45"E) dune-rock overlies to 1,5 m a cemented conglomerate dipping eastward at about 5°. Mr Kilburn could not recognise as pleistocene a few shells in it.

Conclusions on the Minor Emergence; Isotopic dates

In the above account notice has been taken of marine platforms and other indicators of sea-level between 6 m and 9 m which are relevant to the arguments. The following further sites have been recorded:

707 Fort D'acre, rock-terrace at 6 m with riverine pebbles.
705 Riet River bridge, rock-terrace at 9 m with riverine pebbles.
Ship Rock, terrace claimed at 6,6 m (Mountain, 1962).
Cape Recife, terrace at 6 m (Krige).
515 Skoenmakerskop, terrace with cliff at 6 m.
Laurie's Bay, ? terraces at 6 m and 9 m.
508 Seaview, apparently a terrace with fragments of beach-rock from 4,8 m, no cliff.
503 Lower Gamtoos valley, terrace at 6,0–7,5 m above river at many points (Krige, 1927; Haughton, 1937*a*).
319–20 Nature's Valley, probably an alluvial terrace in the village and a rock-terrace with cliff at Blue Rocks at 6 m.
202 Buffelsbaai, Walker Point, probably a dissected platform at 6 m.
026 Noetsie, platform and cliff about 6 m.
034 Struys Point, cave at 6,6 m.
038–9 Cape Agulhas, terrace with pebbles at 6 m, perhaps incised into a 9-metre terrace.

The evidence for two transgressions to 9 m and 6 m is fairly good. On the morphological side, there is difficulty in identifying two platforms on a coast formed of steeply dipping rocks which generally strike parallel to the modern shore, as sub-aerial erosion has attacked platforms and cliffs and dissected the planed surfaces which would be recognizable. Caves are unsatisfactory as there is likely to have been floor-erosion near the mouth during a regression, and sometimes roof-fall has concealed the floor. All the lagoonal and estuarine beds identified seem to belong to a S.L. about 9 m. Storm-ridges cannot be used, as one does not know to what height they would be built above normal S.L. On the other hand, in some estuaries a 6-metre terrace is clearly incised into a 9-metre (414–5 Kromme, 124–5 Kafferkuils), and the same has happened on the open coast at Jeffreysbaai (429–30). At Kasuka Mouth (623–4) calcified estuarine sands seem to overlie both terraces.

Faunal evidence also is unsatisfactory. No fauna can be proved to be associated with the 6-metre terrace, and that which certainly or probably belongs to the 9-metre level is almost entirely modern. We cannot prove that the species peculiar to the Swartkops-fauna, now extinct or living in warmer waters, lasted into the 6-metre period.

The evidence from artefacts is better, though their rarity seldom makes definitive judgment possible; it is hazardous to date a formation from only one or two pieces. It appears however that on the 9-metre terrace there is lightly rolled Late Acheulian and unrolled Sangoan; on the 6-metre terrace there is rolled and unrolled Sangoan, and M.S.A. unrolled and apparently sometimes rolled. It is not easy to date these industries, especially over wide distances across Africa, because there may have been retarded survivals; and dates near the limits of radiocarbon are not entirely trustworthy. In general it appears that in southern Africa the Acheulian industry ended before the beginning or at latest in the early part of the Würm glaciation, while the Sangoan was in use in the Middle Würm, and some M.S.A. dates are as old. This would suggest that the 9-metre terrace was formed by the eustatically high ocean of the Eem interglacial, while the 6-metre is intra-Würm.

We must therefore turn to the isotopic dates of the beaches themselves; we have four for the Southern Cape:

707 Nahoon Point, sample of dune-rock overlying a low-level beach whose maximum altitude is unknown: SR-83 $29090\,^{+410}_{-390}$. The dune-rock was composed of shell-fragments blown up from a beach a little lower than the present. It is reasonable to suppose that the dune began to form immediately after the beach was abandoned. It is however conceivable that the beach is older, and had been covered by terrestrial deposits which were completely removed by sub-aerial erosion before the present dune formed.

701 Rocky Point, shells from a lagoon-bottom deposit at 4,8–6,5 m, above a planed platform of tillite with no cliff exposed: Pta-416 31900 ± 800.

208 Sedgefield, shell-bed at 5 m, estuarine, overlain by terrigenous sand: Y-468 37700 ± 2000.

265 Gerickepunt, shells from beach at 3,8 m on a platform planed in dune-rock: Pta-444 36000 ± 2200. The beach passes beneath dune, so its maximum altitude and cliff are unknown.

Dates for Clasie's River (unpubl.) and Robberg caves are not considered, because they refer to the human deposits in these caves and not to their formation by a marine transgression.

Though these dates are fairly close together and might all refer to a 6-metre S.L. of an intra-Würm interstadial, they are not entirely reliable because shell is not a very satisfactory material for radiocarbon-dating owing to possibility of contamination, and all lie near the limits of radiocarbon.

On the other hand a considerable number of dates has been obtained, from coasts believed to be relatively stable tectonically, for a high ocean-level about 30000 B.P. I do not take into account dates from high latitudes, such as East Ongul Island (Antarctica), Spitzbergen and the Canadian Arctic Islands, where isostatic deformation has taken place, or from coasts where tectonic uplift is not unlikely, such as the Pacific coast of America and Hawaii.

The majority of these dates lie within the Hengelo–Dennekamp interstadial complex (formerly Paudorf), for which dates are given by Van der Hammen *et al.* (1967): Hengelo 39000–37000, Dennekamp 32000–29000 B.P. It is unnecessary to list all the shoreline-dates; I give a few as an example:

Mozambique, SR-72 33720 ± 700 and SR-85 34700 ± 3700 for a midden at 3 m between two beaches and a beach at 5 m; see Barradas (1965).

Senegal–Mauritania, four dates between 31000 and 32500 B.P., I-2771 I-2776 T-464 T-536; see Faure & Elouard, 1967; Elouard *et al.*, 1967; Démoulin *et al.*, 1969.

Australia, at least a dozen dates for a high S.L. during the Würm, but half of them are in the range 30000–20000, i.e. outside the dates of the Hengelo–Dennekamp interstadial. This spread is disturbing; it could be expected if all the high dates are contaminated. See Gill (1968), Gill (1970).

Indonesia and New Guinea, 9 dates: ANU 116–8, 150, 156, 160, 162; NZ-353; UCLA-957. See Grant-Taylor *et al.* (1963: 157); Berger *et al.* (1966: 479); Polach *et al.* (1969: 257).

Among dates from eastern North America, five in particular from the Gulf of Mexico: LJ 383, 521, 526 (Curray, 1960: 255; Hubbs *et al.*, 1963) and Tx 155–6 (Pearson *et al.*, 1965: 298).

Mediterranean, six dates from Corsica, which however do not fit very well into the Hengelo–Dennekamp interstadial (Ottmann, 1969: 23). They are associated with a fauna slightly warmer than today, but not with the *Strombus bubonius* fauna, which occurs at a higher level and is probably not later than the Eem interglacial. For evidence from Alexandria see Zeuner (1952: 46), Zeuner (1956) and Butzer (1960).

In addition, there is some circumstantial archaeological evidence, parallel to that from Nahoon Point, Tiger Rocks and other sites in South Africa. In particular, at Camp Franchet d'Esperey (Algeria) Aterian pieces immediately overlay a raised beach (Camps, 1955); see also Morel (1966).

It has been suggested by Faure & Elouard (1967) that in West Africa there has been slight tilting, so that the beaches identified above modern sea-level were in fact a few metres below it; the ocean rose to near but not above its present level. This suggestion would be acceptable for South Africa, if it is assumed that there has been rather rapid epeirogenetic uplift (of the order of 1 m in 3000 years), which has not disturbed the relative altitudes round the whole coast from Lourenço Marques to Walvis Bay.

On the other hand, glacial geologists, especially in Europe, have found difficulty in assuming an ocean-level anywhere near the modern during an intra-Würm interstadial. Evidence is produced that the ice did not retreat beyond central (Brotzen, 1961) or even southern Sweden; Van der Hammen *et al.* (1967) show that in Holland vegetation did not improve beyond shrub-tundra, with up to 10° July temperature. It is therefore argued that nowhere near enough ice melted to raise the ocean to approximately modern S.L. But John (1967) quotes organic deposits in West Wales (more securely datable by radiocarbon than molluscs), containing pollen of *Pinus* and a fair sample of broad-leaved trees. The dates fall within the Dennekamp interstadial (I-2559, I-2564). Furthermore, almost all the evidence comes from Europe, which was only one of several ice-fields; we do not know what was happening in other glaciated continents, especially Antarctica.

It is clear that the unreliability of radiocarbon at this range makes the problem insoluble, until a good series of dates by thorium is available. There is at present only one promising date from the Mediterranean (L-787B; Stearns & Thurber, 1965) and none from Ethiopia.

VI. HOLOCENE SHORELINES ALONG THE SOUTHERN CAPE

The last pleistocene raised shoreline appears to be that to 6 m, whatever its date. This stage was followed by a deep regression, due to the spread of glaciers in the Würm. At a few places the low-level shoreline has been identified; but in general the evidence is incision by rivers adapting to the lowered base-level. It is almost certain that incision was mainly through unconsolidated fill of gorges cut during older glaciations, at least as far back as the Holstein interglacial.

As the low-level coast was out to sea, it is usually impossible to trace the base of the gorges. We can get depths only near the modern coast, i.e. some way up them where they may have been at less than half their maximum. As figures come from borings for bridges, there has been no attempt to trace floors downstream from the nickpoints to as far as borings can conveniently be made.

The following figures are published for the Southern Cape:

Great Fish River, at the bridge 1,4 km from present mouth, −62 m; this was not the deepest part of the buried channel. Mountain, 1962.

Kowie River, deeply entrenched; piles still in dense sand at −22 m (Roads Department, 1971).

Sundays River, at the bridge 4,5 km from present coast, boulders above the rock-floor at −24 to −27 m. Ruddock, 1947.

Swartkops River, near the railway-bridge 3,5 km from present mouth, cretaceous beds at −14,7 to −18,6 m. Krige, 1927: 20; Schwarz, 1909. At Settlers' Bridge fine sand to below −20 m.

Gamtoos River. Piling for the new bridge on the east side of the valley 4,4 km from present shore has revealed hard sandstone at −47 m below river-level (perhaps +2 to +3 m M.S.L.). Three pile-holes spaced over 250 m across the valley all reached a boulder-bed at −32 m, overlain by sand which is probably marine, the filling of a recent gulf. Shells were found in the eastern pile-hole at about −9 m; I collected *Turritella capensis* and *Crassostrea* sp. Wood-samples from various depths have been collected and taken to America. A sample collected by Mr W. R. Gess from about −9 m S.L. gave the surprising date of 1170 ± 50 B.P. (Pta-407); one would not expect the gulf to be so deep so recently, but the sample may have sunk as the soft sand was churned by floods and storms. The sand is overlain by clay at −2,2, −1,6 and +1,6 m from river-level in three pile-holes from the east to the west side of the valley; this clay appears to be the filling of a channel wider than the present river and probably of recent date.

Storms River, Krige reports rock in the gorge at −25 m.

Keurbooms River, shelly sands recorded down to −33 m (Schwarz, 1905: 81). Section in Martin (1962: 40) shows that rock was not reached at −40 m; the profile suggests two low-level stages, with incision not entirely coincident.

Bietou River, rock not reached at −14,1 m (Schwarz, 1899: 61).

Knysna, rock not reached at −24 m at the railway-bridge, 5 km from present mouth.

Goukamma River. Profile in Martin (1962: 41) indicates rock-floor at more than −18,6 m at the bridge, 5 km from the mouth.

Swartvlei (Sedgefield), channel > −30 m, according to Martin.

Gouritz River. The incised channel (depths not recorded) apparently led to a submarine canyon to −400 m (Krige, 1927).

East of Algoa Bay, from Great Fish River to Kwaaihoek, is a broken line of dune-rock along the modern shore and in places offshore. These aeolianite stacks are clearly founded well below modern S.L., and as they show no trace of the 6–9 metre transgression, they were presumably formed subsequently.

West of Kwaaihoek the conformation of the shore seems to have masked the line of calcified dune with modern shifting sands; but there is a small outcrop on the shore at Deal Party.

The coastal conformation has permitted the exposure of a further set of calcified dunes just behind the shore in the Wilderness area, which is a bay probably of the 9-metre sea. Krige records that the coastal dune-rock at Swartvlei has been traced down to −30 and −37 m.

Dates have just been published of shells from submarine beaches south-west of Cape St. Francis:

−51 m	Pta-183	7580 ± 70	
−112 m	Pta-265	14510 ± 120	
−115 m	Pta-254	13670 ± 120	
−120 m	Pta-185	12990 ± 110	
−130 m	Pta-182	16990 ± 160	(Vogel *et al.*, 1971: 383).

The last date is acceptable for the maximum of the regression, but the three above it are in reverse order and the first date is unexpectedly low for the depth. So probably some of the samples have been displaced.

The ocean rose at the end of the last glaciation. Two curves of its rise have been constructed. On flat coasts with wide shelves Shepard for the Gulf of Mexico and Jelgersma for the Netherlands have postulated a continuous holocene rise, becoming slower in recent times but without the sea having ever been higher than at present. On steep coasts, as in north-west Africa, radiocarbon-dates indicate one or two stands higher than the present within the last 6 000 years. The difference between these two reconstructions is probably due to isostatic adjustment to water-load; either on flat coasts a wide area of water weighs down the spreading shelf and the adjacent coast; or on steep coasts deep water close offshore causes isostatic depression with rebound on the shore itself. It is however not entirely clear how the two curves can be reconciled, as, according to the second, sea-level did not remain constantly above present but fluctuated.

Fairbridge (1961) postulated three high sea-stands during the Holocene, the first and second to the same altitude. They could be identified only by very careful radiocarbon-dating. Between the high stands sea-level dropped, probably to slightly below present; but the range of fluctuation is unlikely to be more than 5 m. This scheme seems reasonable, because at times during the Holocene temperature, at least on a continental scale, has been warmer (e.g. in the Atlantic period) and colder (e.g. in the Little Ice Age) than at present; glaciers have fluctuated, and it is likely that the total water impounded by them has varied.

In South Africa there is evidence for two holocene high sea-stands. There are few published radiocarbon-dates. The most significant are two from Lüderitz, which will be discussed in a later paper: Pta-419 4930 ± 60 for the 3,6-metre beach, Pta-417 1170 ± 50 for the 1,5-metre beach. At Groenvlei near Sedgefield (207) a marine transgression to 0 m M.S.L. is bracketed between 6870 ± 160 and 1905 ± 60 (Y-466–7; Martin, 1956); but what was examined was a marine or estuarine bed below the top of the transgression, which was probably marked by the sandy beach at 2,5 m at Swartvlei (209; Martin, 1962: 35), though there also no cliff was exposed. In Mozambique shells from a rocky beach of a sea up to 1 m S.L., incised into older beach-rock, have been dated 4090 ± 150 (SR-27); *Balanus* on a rocky terrace at 4,5 m, stratified by estuarine water, 4730 ± 200 (SR-29; Barradas, 1965).

Calcified dune occurs in many places on and over the outer lip of the 6-metre terrace, but was seen on the 3,5-metre terrace only at Oyster Bay (404). So since the 3,5-metre

TABLE 3

HOLOCENE PLATFORMS CUT IN AEOLIANITE

Site and number	*Lat.* *Long.*	*Higher Transgression*	*Lower Transgression*	*Remarks*
625–6 Ship Rock	33°39′S 26°46′E	Cave 3,6 m	Cave 1,5 m	
613–4 Carriage Rock	33°42′S 26°40′E	Cliff and caves 3,6 m	Notched cliff and caves 1,5 m	
606–7 Kwaaihoek	33°43′S 26°37′E	Cliff 3,6 m Marine pebbles	Cave 1,5 m	
622 Cannon Rocks	33°45′S 26°33′E	Storm-ridge and cliff 3,6 m		
564 Hougham Park east	33°46′S 25°46′E		Cliff 1,2 m	Dune ? Late pleistocene
542 Hougham Park	33°47′S 25°43′E		Cliff 1,8 m	
536 Winterstrand	34°00′S 25°41′E		Cliff and notch 1,5 m	
538 Beacon Point	34°01′S 25°41′E		Probable beach 1,5 m	Probably in dune-rock
512 Sardinia Bay	34°02′S 25°30′E	Platform in dune-rock and quartzite 3,6 m	Dune-rock and beach-rock below 3,6 m	
510–1 Laurie's Bay	34°02′S 25°24′E	Terrace and cliff 3,6 m	Notched cliff 1,8 m	In both quartzite and dune-rock
432 Ferreiratown	34°02′S 24°56′E	Platform with beach-rock 3,6–3,9 m	Rock-cut platform 1,8 m	
424–5 Cape St. Francis	34°12′S 24°51′E	Terrace to 2,4 m, no cliff	Cliff and notch 1,2 m	
363 Brenton on Sea	34°04′S 23°01′E	Notch 3,5 m		In dune-rock
204 Buffelsbaai Rowwehoek	34°05′S 22°58′E	Beach 3,9 m		Probably incised into dune-rock
266 Gerickepunt	34°02′S 22°46′E		Cliff 1,8 m	Figs 14–15
027 Noetsie	34°27′S 20°44′E	Cliff-base, notch caves 3,6 m		
Skipskop	34°33′S 20°24′E		Notch in dune-rock 1,8 m	
030–1, 033 Arniston	34°40′S 20°14′E	Cave 3,6 m	Cave 1,5 m	Both in dune-rock
035 Struys Point	34°41′S 20°14′E	Cave 3,0 m; storm-ridge 5,1 m		

terrace there has not been time or suitable conditions for calcification.

Platforms with cliff-base, with or without notch, at about 3,5 and 1,5 m M.S.L. are frequent in the Southern Cape. See Table 3.

Platforms cut in hard rock at the two holocene sea-levels are less easy to distinguish, because in the Southern Cape erosion along the bedding of the quartzites has left irregular surfaces which may simulate low cliffs. Occasionally a planed stack (fig. 20) preserves a fragment of terrace. I list in Table 4 only those sites where both levels seem distinguishable; at other sites I have seen one or other of them.

It is difficult to evaluate with which terraces storm-ridges are associated. Even if the modern throw of storm-waves can be determined, storminess may have varied. West of Mossel Bay I observed storm-ridges at several places up to 6 m M.S.L. (Kanon Punt 106, L'Agulhas 037, and see Table 4). These may be associated with the 3,6-metre beach; but the date for Shell Lime Point (below p. 277) indicates that the throw may have been up to 4 m on exposed coasts.

Lagoon-bars also are difficult to date. A bar at 3,3 m (544) at the east end of Hougham Park may be associated with an outcrop of beach-rock to the east (561) and could be holocene.

In many estuaries I observed terraces with boulder-beds at the altitude of holocene sea-levels. These are probably holocene; but there is a risk that they may be exposures far down a higher terrace.

On R. Kariega a rock-platform at 1,5 m is cemented with fine silt and seaward with shelly beach-rock (618). There may be a platform with pebbles also at 3,6 m, but it is much

TABLE 4

HOLOCENE PLATFORMS CUT IN HARD ROCK AT ABOUT BOTH 3,5 AND 1,5 M

Site and number	*Lat.* *Long.*	*Rock*	*Type of evidence*
516–7 Skoenmakerskop	34°02′S 25°32′E	Quartzite	Terraces with cliffs, shelly beach-rock on 3,6 metre terrace
421–2 Seal Point	34°13′S 24°50′E	Quartzite	Notched cliffs
404–5 Oyster Bay	34°10′S 24°40′E	Quartzite	Probable terraces with cliffs
412–3 Hengelaarskroonstrand	34°04′S 24°13′E	Quartzite	Terraces with cliffs
304–8 Storms River mouth	34°01′S 23°54′E	Quartzite	Caves and terraces with cliffs
325–6 Keurboomstrand	34°00′S 23°27′E	Shale	Cliff-bases and caves
350–1 Noetsie	34°05′S 23°07′E	Quartzite	Probably terraces and cliffs; storm-ridge to 4,5 m
355–6, 361 Knysna Heads	34°05′S 23°04′E	Quartzite	Terraces and cliffs, cave. Fig. 20.
231–2 Glentana	34°03′S 22°19′E	Granite	Notch and cave, ledge with cliff
117–8 Voëlklip	34°22′S 21°52′E	Quartzite	Terraces and cliffs, storm-ridges to 5,5 and 7,5 m
130–1 Piet Rogsbaai	34°25′S 21°22′E	Quartzite	Terraces and cliffs, storm-ridges to 3,6 and 5,1 m
133–4 Grootjongensfonteinstrand	34°26′S 21°20′E	Quartzite	Probable cliff-bases partly masked

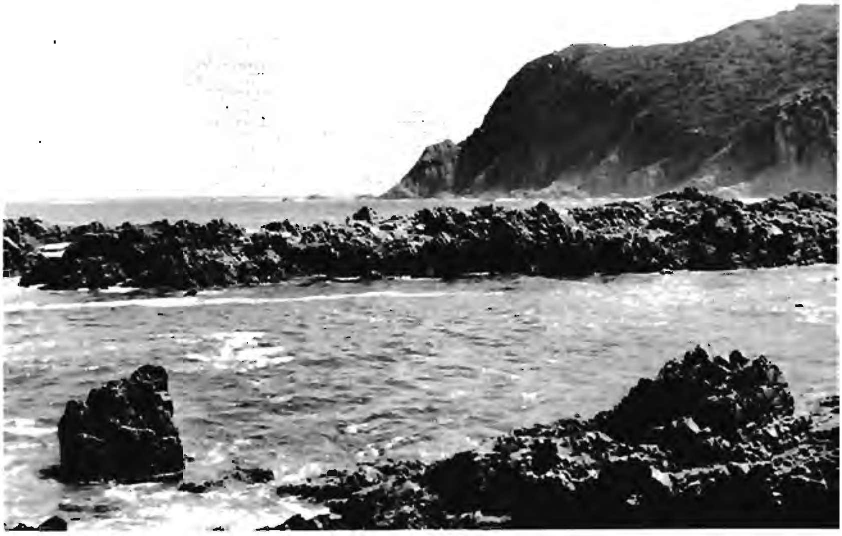


Figure 20
Coney Glen, Knysna, 3,6-metre terrace preserved as stack, site 355.

masked by dune. On Bushmans R. is a terrace at 1,5 m, covered by boulders and cemented (610; perhaps pre-holocene, above p. 250).

Ruddock (1947) considers that the Colchester Terrace on Sundays R. (549), at 4,5 m above river at the bridge, graded to a S.L. about 3,6 m.

The camping-site at Maitland Mouth west of Port Elizabeth is an estuarine terrace at 4,2 m, probably associated with the 3,6-metre S.L.

Close to the mouth of R. Gamtoos are remains of a beach up to 1,5 m, with derived fragments of beach-rock (505). An estuarine flood-plain extends down the valley, dipping gently from 3,3 m above river at the bridge (504) towards the mouth (for date see p. 265).

At the mouth of R. Kromme there is a grass-covered flood-plain at 1,5 m and a rock-cut terrace at 3,6 m (416–17).

There are alluvial flats at about 3,8 and 1,8 m M.S.L. in the Groot-Brak (234–5; see Dreyer, 1934) and at 3,3 and 1,5 m in the Klein-Brak estuaries (244, 238).

In the Breë estuary are terraces with cliff-bases at 3,6 and 1,5 m M.S.L. (011, 009) upstream from Port Beaufort Hotel.

Estuarine flats lower than 1,5 m, with modern shells, are recorded some distance up R. Kowie and Bushmans R. (Mountain, 1962).

I observed at several points abrasion-platforms, some with low notched cliffs, at roughly +0,6 m (3 sites), +0,3 m (1 site), 0 m (4 sites), −0,6 m (7 sites) and −0,9 m (1 site). Some of these may be active today. Others probably belong to minor fluctuations in ocean-level since the 1,5-metre beach. Such have been recorded from other parts of the world; but only under special circumstances is there any possibility of dating them.

VII. THE SOUTH-WEST CAPE, CAPE AGULHAS TO CAPE TOWN

In the South-western Cape and particularly in the Cape Peninsula there are few indications of quaternary shorelines above 30 m. Nor do the high levels east of False Bay fit those claimed in the Cape Peninsula. So probably there has been tectonic movement since the Middle Pleistocene. The beaches beneath the Kleinriviersberg and round the Hangklip mountain-complex up to 73 m can on altitude be fitted to the series in Natal; so this stretch may have been fairly stable.

Near Hermanus, Cape Hangklip and Cape Town, Breuil (1945, 1948) described gravels and scree which he claimed as marine, with rolled and unrolled artefacts. The South African Museum holds some of his collections; but it appears that his records were so faulty that it has been impossible to pinpoint his sites. His measurements were inaccurate, and his claims for rolling must be treated with caution. He may have removed some pieces to Paris, and he probably mentioned material in private collections which cannot be traced today and is likely not to have been properly documented. Even less confidence can be placed in Gatehouse's (1955) geological descriptions and measurements. I have paid careful attention to the words of both authors. To save space, I have not listed all their errors; in cases of difference it may be taken that my figures or reports are more accurate than theirs. Many of their sites I have omitted because I have been unable to find them or consider them wrongly described and not relevant to my paper.

I will first discuss the unsatisfactory indications of sea-levels above 30 m.

The 45-metre level

A level at this altitude has been found in Natal and near Riversdale (Davies, 1971: 220). There are traces of it round Walker Bay. At Klip Kop, Hermanus, is a cave at 45 m (C35); it may not be marine, but eroded into fissures in the T.M.S. Behind Klip Kop, however, close to the transformer-station, are pebbles up to 45 m and a steep rock-rise; I found several unrolled Late Acheulian hand-axes but nothing rolled. At Rocklands, near the Yacht Club, pebbles up to 45 m abut against a rocky ridge, probably a former promontory (C26). At Die Kelders, towards the south end of Walker Bay, pebbles are exposed on a rock-slope emerging beneath dune at 45 m (C17); no cliff is exposed, and the exact level of the terrace whence they have been derived is uncertain. The paucity of shell shows that this exposure is not midden, though there is probably midden lower down, apparently under the fossil cliff of a lower terrace.

The 45-metre level appears also on the steep slopes overlooking False Bay on the east. Above Koeëlbaai is a spread of well-rolled pebbles on an even slope from about 67 to 24 m (C70–2). The slope is steep for marine planation; I suspect that it is an erosional surface bevelling perhaps three marine terraces. The hillside is however too overgrown to shew small pebbles or other beach-indications. The upper boulders are wind-blasted and sometimes sub-angular, the lower are better rolled. This suggests reworking of marine boulders by a series of transgressions. I found no artefacts among the pebbles.

There are many large rolled pebbles on a platform abutting against a former rock-promontory in a cutting on Faure Marine Drive, Gordon's Bay (C79). The altitude is about 50 m S.L. Some show incipient cones of percussion. Flattened well-rounded marine pebbles appear also at the back of the town just below a house called Bosun's Chair, up to 48 m where very large boulders may mark the base of the cliff which is not exposed.

The 60-metre level

Besides Koeëlbaai (C70), there is one exposure of a 61-metre beach, in Vredendal (C52) in the angle of the Kleinmond and Hermanus roads. On a wide rock-cut platform is a spread of pebbles embedded in laterite. The site may be a fossil estuary of Bot R., and there is no cliff. It appears to be the place recorded by Breuil (1948: 62). Among the pebbles I found a few weathered but probably unrolled artefacts (NM 70/7). Three pieces seem to be M.S.A. cores; the fourth is a crude small pick, which is not easy to date.

Levels above 60 metres

I am uncertain about a marine platform at 73 m in Bosch Heuvel east of Stanford (C22); the pebbles on it are poorly rolled. Breuil's claim of a terrace at about 75 m behind Klip Kop, Hermanus, seems to refer to the quarry at the transformer-station (C35 above), which is at 150 feet, not 250 feet.

Near Kouevlakte, just north of MS 18 on the road from Stanford to Gansbaai, roadworks have revealed white rolled pebbles and coarse calcified sandstone, apparently beachrock, at 94 m (C19). The section is partly concealed, but can be reconstructed:

dune-sand
probably more than 1 m of beach-sand
pebble-bed
probably rock-terrace.

The beach may have been in a narrow bay. Rock probably rises to north and south, but is concealed by dune.

Beaches above 30 metres in the Cape Peninsula

There is practically no evidence in the Cape Peninsula for pleistocene high sea-levels. Breuil's (1945, 1948) 'beaches' at Simonstown and Pollsmoor, containing rolled Acheulian I–II and unrolled Acheulian III, were probably modern quarries with scree mixed with a few derived pebbles. Behind Simonstown I found nothing. South of Pollsmoor I found at about 73 m very large boulders (C85) which may not have rolled from far, and to the west, close to the lowest hairpin-bend on the Ou Kaapse Weg, a new quarry for scree mixed with well-rolled pebbles up to about 110 m (C84). There was no evidence whence the pebbles had come, and they had been well mixed with the scree by natural slip. Among them was a doubtful rolled chopper and an unrolled chopper.

At Cape Maclear there appear to be two zones of pebbles. In the lower, at 64–70 m, a layer of fine ferruginised sand, possibly beach-sand, is mixed with scattered pebbles and appears to fill two depressions separated by a ridge, marked as pt.246 (C104). They seem to end in a degraded cliff. This is probably the isthmus which Mabbutt (1954*b*) associates with a shelf along the Atlantic coast. Among the pebbles I saw two pieces of sand-blasted M.S.A.

The main palaeolithic site (C103) is a scatter of pebbles and ferruginised gravel at a higher level, up to 85–90 m; it has yielded Early Acheulian, apparently unrolled (Jhb 9/38/5), and M.S.A. Gatehouse (1955) and Breuil considered it a beach-gravel, Mabbutt suggests that all the pebbles had been humanly transported. Their upper limit is fairly sharp, but there is no true cliff. They may be detritus from an eroded beach above 90 m.

The 30-metre sea-level

There is a good series of 30-metre exposures as far as False Bay; in the Cape Peninsula this level is poorly attested. Along the Tzitzikama–Outeniqua ridge also (Davies, 1971: 207, 211) I doubt if a 30-metre terrace can be identified. So tectonic movements probably ceased after this stage.

I found no trace of the terrace (902) which Krige claims at 24 m and 27 m at Brandfontein, at the foot of the Zoetanysberg. All along the coast as far as Gansbaai mountains rise steeply from a wide coastal plain at 40–60 m. The foot of the range is masked by thick calcified dune, which conceals any cliff-base.

There are marine pebbles, not laid, on a terrace on the north bank at Stanford Bridge at 30 m (C23), but no cliff is exposed. To the west, in Zilvermynsbosch, Breuil (1948) on a pebble-beach at 24 m found unrolled Late Acheulian pieces; I traced pebbles up to 30 m (C25), to the foot of the mountain. There may be traces at Mossel Bridge of a terrace at 39 m, which would grade to the 30-metre sea.

The principal scatter of rolled pebbles beneath Cape Hangklip almost certainly comes from an 18-metre terrace and will be discussed below. There is also a patch of well-rolled pebbles at 28 m (C62), just beneath the steep rise, probably the remains of a 30-metre gravel which is difficult to trace owing to thick vegetation.

On Faure Marine Drive behind Gordon's Bay there used to be a patch of laid pebbles at about 33 m (C80; fig. 21). These I saw in 1953, and they are recorded by Gatehouse (1955)

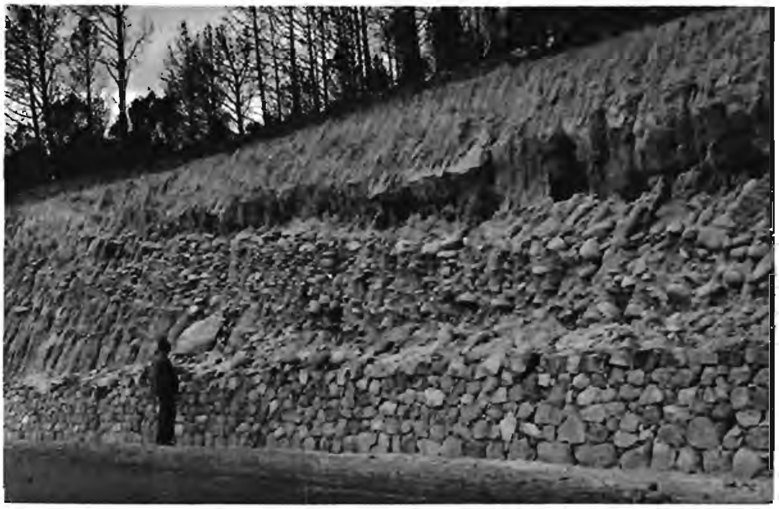


Figure 21
Faure Marine Drive, Gordon's Bay, 33-metre marine gravel, now fallen; photo 1953; site C80.

and Bowie (1966). Before 1969 the face of the cutting had fallen, leaving sand and sandy rock. The exposure must have been at the extreme head of a cove debouching south-westward; the pebbles would have been banked against the cliff, with S.L. about 30 m.

On the eastern side of the Cape Peninsula there are doubtful remains of a 30-metre shore. The surface of a ridge of quartzite south-west of Clovelly golf-course, Vishoek (C86), may be part of a wide 30-metre platform, though no cliff is visible and intense sand-blasting has destroyed any water-worn boulder-surfaces. Gatehouse speaks of scattered pebbles and shells at 28 m just above Sunny Cove station, Vishoek. What he had seen may have been midden rather than beach.

In the Cape Point Reserve the sandy limestone at the foot of Paul's Peak (C100), noted by Krige, has been examined afresh and pronounced to be probably aeolianite. Caves at 30 m seen by Krige at Smitswinkelbaai (C98) and by myself at Olifantsbos (C107) cannot be accepted as marine without confirmation.

The 18-metre sea-level

As along the Tzitzikama–Outeniqua coast, the 18-metre level (Krige's Major Emergence) is the oldest that is regularly traceable from Cape Agulhas right round to Cape Town. It was shortly before that stage that coastal tectonic movements seem to have ceased.

There may be an 18-metre terrace, as Krige claims, on Ratelrivier (905); but it is covered by calcrete and sand, and carries no marine remains. A wide terrace is claimed also at Klein Hagelkraal (909), again without marine remains.

Heavy dune-cover conceals the whole coastal area as far as Stanford. The town stands on a wide plain (C21) on which the O.S. gives two readings, 17,0 and 17,6 m; it is erroneously put by Breuil at 28,5 m (95 instead of 59 feet). The plain is formed of sandy clay containing large rolled boulders, probably an estuarine deposit of Klein R. Close to the present river is riverine gravel and gritty sand, perhaps deposited at the start of the regression while the clay belongs to a S.L. at 18 m or slightly higher. An 18-metre terrace may be traced also down the north bank of the river.

Hermanus is built on a wide terrace, of which the back, at Eighth Avenue at the foot of Klip Kop, is at 20 m (C36); the same terrace, at 18–24 m, appears at the mouth and bridge of R. Mossel (C29–30). It continues westward and may be seen again at Onrus (C44) and at Hawston (C51), and probably at 23–4 m on R. Palmiet (C56).

There is a large spread of quartzite pebbles at Cape Hangklip (C63). The descriptions of the site are more than ten years later than its discovery in 1934 by F. Malan. Accounts of its original appearance must go back to him, and may have been inaccurate after the lapse of time. The site is described by Breuil (1948). I was there is 1953 and took notes; published accounts by Mabbutt (1954*a*, 1955: 12) and Gatehouse (1955) depend on visits of about the same date. The site is today much covered by dune and bush, and roads have been altered. Pebbles extend now along the road from the hotel towards the harbour, and stop about where the new road to Silver Strand diverges. They spread up to 16,5 m, and it is agreed that they are derived from a terrace about 18 m with cliff-base masked by dune and talus. They lay in dark sand, which continues on the talus above where they stop but contains here only rubble. Malan said that he found pieces of the Stillbay industry on the sand.

Many pebbles have been made into artefacts. Breuil classes the unrolled ones as Acheulian V; I consider that there are pieces typologically older, and Mabbutt thinks that they cover the whole Acheulian typological range. I found in 1969 no rolled pieces, only a few which are heavily weathered and of poor stone. Breuil claims rolled pieces, and Mabbutt says that the typologically older pieces appear rolled. Gatehouse reckons seven rolled Early Acheulian pieces. Possibly the rolled pieces which Breuil saw were in Malan's collection and not on the site, and may have come from elsewhere. Three pieces in the South African Museum (5717), claimed as rolled, are wind-abraded.

On general grounds, one would expect everything older than Late Acheulian in an 18-metre beach-gravel to be rolled. The poor documentation of any rolled pieces suggests that the site was not previously occupied by man. Nothing is extant worth illustration, to give a *terminus post quem* to this sea-level.

Krige (1927), Haughton (1933) and others speak of a marine terrace at 15–18 m at Rooiels and a cave at 20 m up the stream (C67 C69). The terrace can be identified on the west side of the bay towards the point, and probably along the coast southward towards and south of Pringle Bay up to 15 m, with stacks rising higher. There is also an exposure of pebbles at 18 m on the coast-road at MS 9 north of Rooiels.

There appears to be a narrow terrace with cliff at 18 m at Boskloof Point (C75), and a platform at 21 m on both banks of R. Steenbras at the bridge near the mouth (C77). Bowie (1966) considers that this platform is structural rather than marine-planed. A thin scatter of rolled pebbles on and above it may be derived from a higher level.

It is unnecessary to dilate on the gravels beneath Stellenbosch. The general opinion is that they are riverine, fanning out as they debouch into the plain (Shand, 1913). The Eersterivier valley is well cultivated, so it is impossible to trace terraces on the surface; nor do the dunes allow them to be followed into False Bay. No adequate record has been kept of artefacts from the gravels. Breuil, who was most qualified to do this, seems to have adapted his observations to his geological theories. There may be a river-terrace grading to an 18-metre level (the 9–14 metre terrace according to Seddon (1966)), and other terraces to lower sea-levels.

At Glencairn, between Vishoek and Simonstown, on the north bank of Elsiesrivier I found very large rounded T.M.S. boulders at about 18 m (C87). Their size suggests that they came from the head of a beach nearby. Breuil records a beach-terrace at 21 m near Vishoek with unrolled Late Acheulian; this site cannot be identified.

Nearly opposite Spaniard Rock, 500 m south of Rocklands Point, the main road has sectioned a boulder-beach on a slightly uneven granite surface, measured by Bowie as 16,8 m S.L. (C93; Haughton, 1933; Gatehouse, 1955; Bowie, 1966; Birch, 1968). It consists of large and small pebbles in coarse sand, over a metre thick at the south end which seems to be the head of a cove. It thins northward and is overlain by sub-angular gravel, probably a stream-deposit during the marine regression. The same beach outcrops a short way to the north at Froggy Pond, behind the Administration Buildings of the Cape Times Fresh Air Camp, where the platform is at 18,6 m.

On the west side of the Cape Peninsula Haughton (1933) records a beach at 18–21 m at Witsand (C111); this area is now inaccessible. I am uncertain where Krige identified a 12–13 metre terrace at Llandudno (C117), perhaps north of the village where the granite is very dissected but at present rises to about this altitude; the original terrace was probably higher.

At Hottentotshuisiebaai south of Camps Bay the road sections a boulder-beach at 18–21 m (C118; Haughton, 1933). I am uncertain if the pebbles are laid. If they are *in situ*, the cliff must have been close behind, but is not exposed.

At Green Point Common Krige notes a marine terrace at 12–14 m, Haughton at 15 m. The place has undergone urban development and cannot be accurately surveyed, especially for altitude.

The 9-metre and 6-metre sea-levels

Along the whole of this coast, including the Cape Peninsula, terraces notches and caves occur at about 9 m and 6 m. Occasional shoreline-indicators which have been measured to 7,5 m (C18 Die Kelders, excavator; C105 Cape of Good Hope, platform with shingle to 7,5 m, Mabbutt) may not be Late Pleistocene features but earlier shorelines exhumed. Krige's ledge at 7,5 m in aeolianite at Paulsberg may be due to wind-erosion.

I am not listing sites which seem unimportant or which are listed by Krige and I have not seen. Table 5 comprises those where both the 9-metre and the 6-metre S.L. are attested on adjacent traverses.

The 18-metre beach at Cape Hangklip (C63, see above) is separated from a lower pebble-spread by a rock-ridge, against which is piled a storm-ridge (C64) to about 7,5 m (6,9 m according to Birch). In 1953 these separate stages were clearer than today, and were noticed by Mabbutt (1954*a*). Below the storm-ridge the pebbles are smaller than above. Acheulian hand-axes are rare below 12 m, and may have been displaced by modern collectors. There were unrolled M.S.A. cores, which however may have lain not among the pebbles but on now eroded sand above them. On the lower pebbles there were in 1953

TABLE 5

SHORELINES OF THE MINOR EMERGENCE, SOUTH-WEST CAPE

Site and number	*Lat. Long.*	*9-metre stage*	*6-metre stage*
911–2 Franskraal Strand	34°36′S 19°24′E	Wide rock-terrace *c.* 9,6	? terrace, Seal Island, *c.* 6,0
914–5 Vandyksbaai	34°37′S 19°22′E	Terrace rising from 10,5, no cliff, perhaps an older stage	Terrace with cliff 6,0, covered by aeolianite
C01–02 Danger Point south	34°37′S 19°19′E	Terrace, pebbles at base of calcified dune 9,0, no cliff exposed	Terrace, cliff 6,0, covered by aeolianite
C09–10 Stanford Bay	34°34′S 19°21′E	Terrace, cliff 9,0	Terrace, cliff 6,0
C13–4 Die Kelders	34°33′S 19°22′E	Terrace caves stacks, no certain cliff, 9,0	Caves 6,0
C31–2 Mossel River mouth	34°24′S 19°16′E	Terrace 9,0	Terrace 6,0
C37–8 Hermanus w. bathing place	34°25′S 19°14′E	Terrace 10,5, cliff	Terrace cliff 6,0
C47–8 Mudge Point	34°25′S 19°07′E	Terrace cliff 9,0	Terrace cliff 6,0
C90–1 Froggy Pond	34°12′S 18°27′E	Terrace 9,0, no cliff	Terrace cliff 6,0
C94–5, C97 Miller's Point	34°14′S 18°29′E	Terrace 9,6, cliff masked	Terrace cliff 6,0

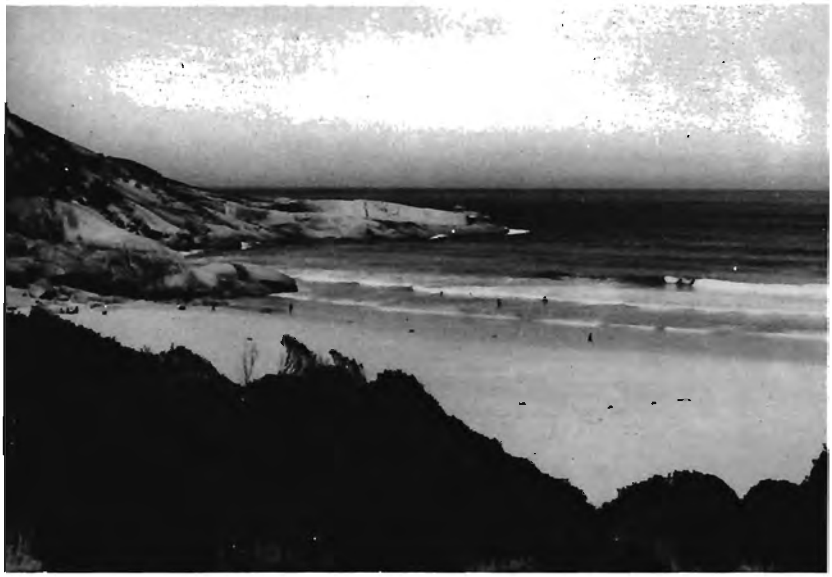


Figure 22
Llandudno, 6-metre and 1,5-metre terraces on promontories, sites C115–6.

dune-ridges carrying recent middens. The S.L. of the lower pebbles was probably the 6-metre transgression, which could well pile a storm-ridge against a low cliff.

At Uilkraal (910) the pebble-beach behind and apparently incised by the modern sandy beach (Krige, 1927) has been much broken up by a camping-ground. I could trace pebbles to about 5 m S.L., and they may continue a little higher beneath dune, but give out before a large pit on the main road. The beach probably is one of those of the Minor Emergence.

It may be chance that along the eastern side of False Bay only 9-metre platforms have been detected (C68 Rooiels, C73 Koeëlbaai, C76 Boskloof Point).

The 6-metre terrace cut in granite at Llandudno is illustrated (fig. 22), with the 1,8-metre terrace on the smaller promontory in the foreground (C115–16).

Fauna can nowhere be proved to be associated with either the 6-metre or the 9-metre terrace. It occurs rarely on low-level platforms without cliff-bases, which may rise to one of these levels. At Wortelgat (C24) Barnard (1962) and Wybergh (1919) record shelly limestone at nearly vlei-level, i.e. hardly above M.S.L., whence were collected *Spondylus* sp., *Lima fragilis*, *Anodontia edentula*, *Tellina trilatera*, and *Rocellaria* cf. *dubia*; Mr Kilburn has told me that the first three do not occur in this area today. This beach may well be continuous with a sandy beach with shell-fragments two metres thick at not less than 9 m S.L., which I observed beneath calcified dune about 1,5 km east of Wortelgat; I noticed another beach with cemented sand at not less than 6 m.

On the north shore of False Bay a wide terrace cut in Malmesbury shales appears to rise very gently from about M.S.L. on the present coast to an unknown height inland. The modern shore is in places bounded by high cliffs in poorly consolidated aeolianite. It is unlikely that the caves at different altitudes in these cliffs, especially near Swartklip, have been sea-cut, as the dune-rock seems to suffer rapid wind-erosion and scarp-retreat. The dunes cannot be dated; they resemble dunes on other coasts of South Africa which have been formed during the last marine regression, and not the very hard older aeolianites which have been planed by transgressions of the Minor Emergence.

The best exposure of the rock-platform is at Strand (C82; Bowie, 1966). It is visible in the intertidal zone up to about M.S.L., with gradient of about 1 : 150. I have no evidence how far inland it extends. R. Lourens at Somerset West is at about 20 m, and the pebbles in this area are ill-rolled and probably riverine. At Swartklip, Mabbutt (Gatehouse, 1955: 263) records beneath the aeolianite a dark sand with estuarine shells. He does not comment on this, and apparently did not find the rock-platform; he may have seen a fossil mouth of R. Kuils. Farther west, towards Strandfontein, there is shelly beach-rock at least 2 m thick, continuing out to sea and probably deposited on the platform during a regression.

At Sandvlei Mr A. Tankard showed me a zone of modern estuarine and marine shells 0,5 m above the vlei (about 2,3 m M.S.L.) in sands which must have been laid down under water (C181). Mr Kilburn received a collection from presumably the same site, which included extinct species. The beds are unlikely therefore to be holocene. Urban development makes it impossible to trace the limits of the transgression.

There is not much evidence for the date of the 6-metre terrace on this stretch of coast. At Cape Hangklip it appears to be earlier than some stage of the M.S.A. At Hout Bay (C114) Professor R. R. Inskeep showed me a pebbly beach exposed up to 4,5 m with cliff-base masked by dune, probably associated with a marine cave 200 m to the north at over 7,5 m. On the dune is a midden with broken pebbles and shells, whence a date of $47100\,^{+\,2800}_{-\,2100}$ has been obtained (GrN-5804; Vogel, 1970: 462). Whatever the maximum of the transgression, the date is too old for an intra-Würm interstadial.

Holocene sea-levels

Calcified dune extends below 6 m at Kruismansbaai and Swartklip; but there is no evidence in the South-west Cape for its occurrence on the 3,6-metre terrace, believed holocene. It was probably formed during the last major regression.

The terraces at about 3,6 and 1,5 m which are believed to be holocene have been observed at many places along this coast as in the South Cape. They occur together at the following: 916–17 Vandyksbaai; 919–20 Kleinbaai; C03–4 Danger Point south; C11–12 Stanford Bay with beach-rock on the lower terrace; C15–16 Die Kelders; C27–8 C33–4 Voëlklip; C39–40 Hermanus; C49–50 Mudge Point; C96 Miller's Point ?; C109–10 Olifantsbos. For the 1,8-metre rock-cut terrace at Llandudno (C116) see fig. 22.

Principally on the exposed westward-facing coasts of the South-west Cape there are high storm-ridges, composed mainly of large pebbles of hard quartzite. The throw has been considerable. At Shell Lime Point there are rock-terraces at 3,6 and 1,5 m (C41–2), and a banked storm-ridge with crest at 5,7 m, consisting mostly of comminuted shell with a few small pebbles. A sample of *Argobuccinum argus* gave a date of 2300 ± 50, Pta-445; so the ridge is probably associated with the lower and later transgression. The modern throw of storm-waves here is about 2 m. The ridge may be traced slightly lower round Sandbaai (C43).

Consequently, all the extant storm-ridges, apart from those banked against cliffs, may be holocene, associated with either the 3,5-metre or the 1,5-metre levels. I would be inclined to classify as holocene the ridges on the east of Buffeljags Bay with crests at 6,9 m (Krige 7,8 m) and 5,1 m (907–8), at Franskraal Strand at 6,0 m, 3,3 m and 1,8 m (913), on the north-west of Danger Point at 6 m (Krige 4,6–5,2 m, C05), behind Kommetjie at 7,5 m and 4,5 m (C112–3). On sheltered coasts ridges should be lower. On the sheltered side of Cape Hangklip (C65) Mabbutt traced ridges at 3,3–5,4 m, I saw them round Van der Ratsbaaie at 3,0–3,6 m; these should be associated with a rock-terrace at 1,6 m at Ospunt. In Gordon's Bay Krige saw ridges up to 3,0 m, now probably beneath the bayside-road at the south-west end of the town.

ACKNOWLEDGEMENTS

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NOTE. The shorelines of the Western Cape, north of Cape Town, will be described in a subsequent paper, as will the excavations at the estuarine beds of Coega Mouth (Salnova).

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Items not in this list will be found in the Bibliography at the end of part 1 of this paper.

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